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An Account of the Roslyn House Observatory

By ORREN MOHLER

Roslyn House Observatory has become widely known as one of the best equipped amateur astronomical observatories in the world and during the last year has partially made use of its equipment for astronomical research in coöperation with Sproul Observatory of Swarthmore College. Introduction of a definite program of observation makes desirable a somewhat detailed description of the observatory and the researches in progress and contemplated.

FIGURE 1.
A GENERAL VIEW OF THE ROSLYN HOUSE OBSERVATORY.
(Photograph by Dr. E. N. Fought)

The observatory is located on the Roslyn House estate of Mr. G. W. Cook, its owner, in Wynnewood, Pennsylvania. The geographical coordinates are: latitude N 39° 59′ 45″; longitude W $05^h\ 01^m\ 05^s$. The design of the two observatory buildings housing the instruments has been carefully worked out so that the observatory fits perfectly into a charming flower garden. Centuries old English boxwoods line the

buildings and completely mask any hint of newness. One can get only a very inadequate idea of the beauty of the garden from the accompanying photographs.

A light wood frame construction has been used for the houses in an attempt to avoid the bad temperature effects of heavy structures. Those rooms which are heated are well insulated, which keeps convection currents negligibly small, even in very cold weather. The Star House, the larger of the two buildings, houses an equatorial mounting which carries a 28½-inch reflector, an 8-inch and a 6-inch refractor, and camera with

FIGURE 2.
THE SUN HOUSE.
(Photograph by Dr. E. N. Fought)

a 4-inch aperture lens; a 3-inch transit instrument; a computing room; and a horizontally mounted 15-inch refractor. The computing room and the observing room of the horizontal telescope are tastefully furnished with early American pieces which add not a little to an appearance of completeness and perfection. Even the hooked rugs on the floor portray stars and constellations. A sliding roof covers the reflector and its accompanying telescopes; the transit is opened to the sky by removing the usual shutters; while the siderostat which feeds the horizontal telescope has a rotary flat roof with a wide slit opening covered by shutters.

The Sun House contains the camera of a forty-foot focal length horizontal telescope, a room for photographic work and a spectrohelioscope. The lens and flat of the forty-foot telescope are placed on a pier to the north of the building and the coelostat and object lens of the spectrohelioscope are on a pier to the south. The optical parts on the two piers are protected from the weather by light wooden covers.

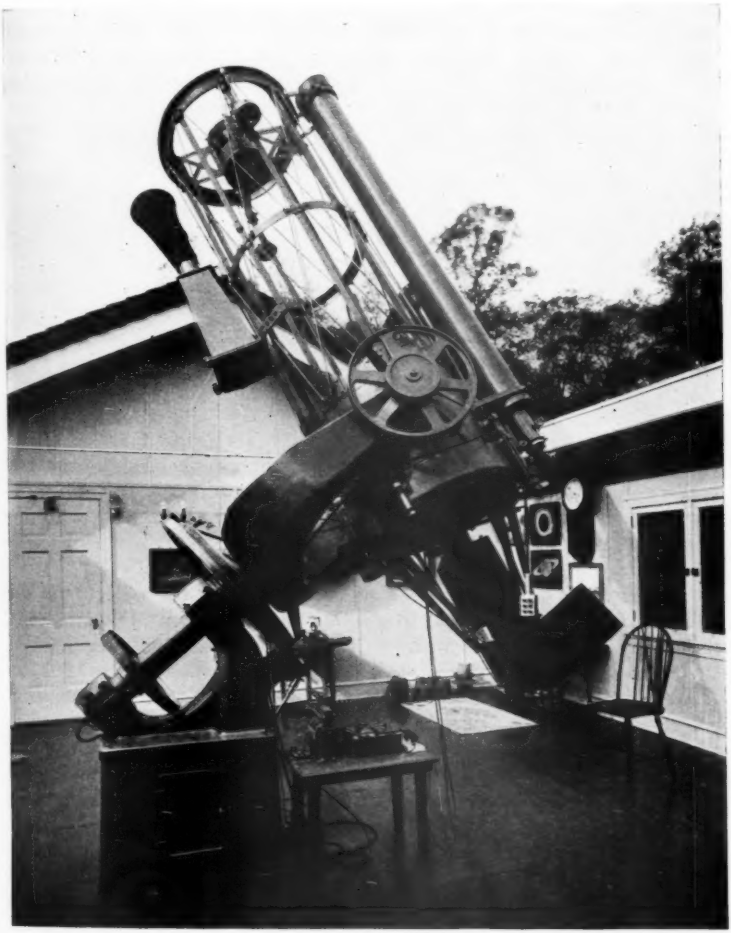

FIGURE 3.
THE 28½-INCH REFLECTOR WITH THE SPECTROGRAPH ATTACHED.
(Photograph by Mr. G. W. Cook)

The 28½-inch reflector is the largest instrument at the observatory. The J. W. Fecker Company of Pittsburgh, Pennsylvania, designed and built the instrument and its accessories. Among the accessories are a double-slide plate holder, a two-prism stellar spectrograph and numerous eyepieces. Modern light-weight alloys have been used in the construction to save weight without too great sacrifice of strength. An open fork mounting carries the mirror and a light-weight skeleton type aluminum tube. The fork is long enough so that all regions of the sky can be reached except when the spectrograph is attached. With the spectrograph on the telescope, declinations greater than seventy degrees north are unavailable. A synchronous motor drives the telescope in right ascension. No attempt has been made to secure better than average guiding by controlling the frequency of the current supplied. The guiding with the commercial current has been satisfactory. Slow motions in both coördinates, and also the focussing of the Cassegrainian secondary are electrical. No fast motions are provided and none are necessary, for the telescope is easily moved by hand. The primary mirror has a clear aperture of twenty-eight and one-half inches and a focal length of one hundred and forty inches. There is a six-inch hole in the center of the mirror through which the starlight passes in the conventional Cassegrainian arrangement. Two secondary mirrors have been supplied, one is an optical flat for observing at the principal focus in the Newtonian arrangement, the other is a hyperbolic mirror to be used as a Cassegrainian secondary. The equivalent focal length of the Cassegrainian form of the telescope is thirty-five feet. The plate holder for the telescope is designed for plates three inches square. There are two guiding eyepieces, one eyepiece is set at an angle for zenith observation. Provision is made for complete rotation of the plate with fine adjustment, in addition to the usual double slide motion in both coördinates.

One of the more unusual bits of equipment for the reflector is the stellar spectrograph. The spectrograph is built in the main of an aluminum alloy in order to get great strength with reasonable weight. The saving in weight is most noticeable in attaching and removing the spectrograph from the telescope, and makes the spectrograph more convenient to use than a heavier instrument. The two prisms give enough dispersion so that a short camera may be used for gaining speed. Two camera lenses, each of nine inches focal length, are used. One of the lenses is figured for the visual region, the other is designed for the blue to ultra-violet portion of the spectrum. Each has been designed for excellence of definition rather than to cover a wide extent of spectrum in fair focus. Means for introducing comparison spectra as standards of wave-length and standards of intensity for spectrophotometric purposes have been added and are being developed for the instrument. A temperature jacket constructed of synthane and balsa wood keeps the instrument at a constant temperature. The temperature control is effected through relays actuated by mercury thermometers, the mercury in the

thermometers being under high gas pressure. The jacket can maintain the temperature in the prism cell within less than a tenth of a degree with a temperature difference of one hundred degrees Fahrenheit between the internal and external temperatures.

An eight-inch visual refractor, the lens by Clark and the mounting by Fecker, and a six-inch visual refractor by Fecker are carried on the tube of the reflector. The six-inch serves as a finder for the reflector, while the eight-inch is used for visual observation and for guiding the four-inch Ross-Lundin camera, which also is attached to the reflector tube. The camera for the Ross-Lundin lens is by The Eastern Science Supply Company.

FIGURE 4.
COMPOSITE PHOTOGRAPH OF THE 15-INCH OBJECTIVE AND THE SIDEROSTAT OF THE HORIZONTAL TELESCOPE.
(Photograph by Mr. G. W. Cook)

Second in size among the instruments of the observatory, but without doubt the most interesting instrument is the horizontally mounted fifteen-inch refractor. The design of the unusual feature of the instrument is a refinement of a type of siderostat built by Repsold for the Potsdam Astrophysical Observatory. In this arrangement, an optical flat in an alt-azimuth mounting is driven by a connecting link-work attached to an equatorial axis in such a way that light from a celestial object falling on the flat is reflected in a fixed direction.

The fixed direction in this case is the north-south line and the fifteen-inch refractor is horizontally mounted in this line facing the center of the optical flat. This type of mounting offers the advantages of the fixed eyepiece and warm observing room of the equatorial coudé, or the ordinary horizontal telescope using a coelostat, while avoiding the high tower necessary for the coudé in these latitudes and the double reflection of the coelostat. The motions, fast and slow in both coördinates, as well as the drive, are electrical. The driving, as with the re-

flector, is accomplished with a synchronous motor. At the eyepiece end of the instrument a panel board shows the position of the telescope in hour angle, right ascension, and declination, and the position of the slit opening in the rotating roof on appropriate dials. Self-

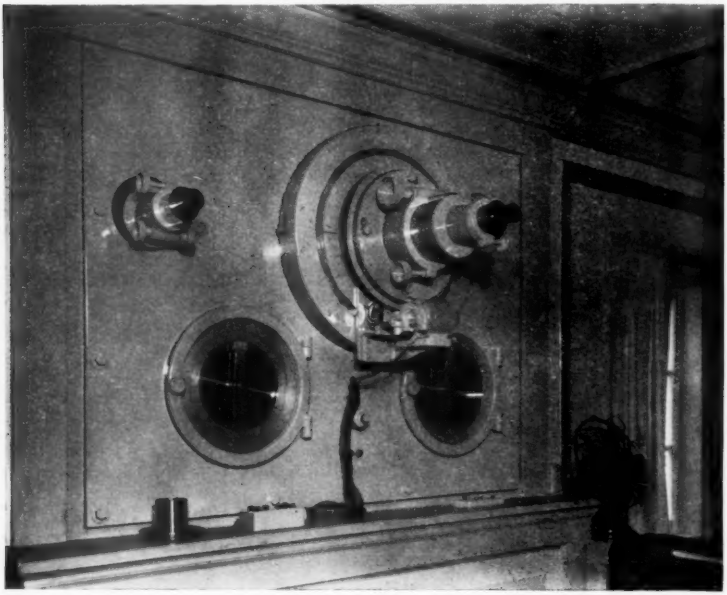

FIGURE 5.
THE EYEPIECE AND PANEL BOARD OF THE HORIZONTAL TELESCOPE.
(Photograph by Dr. E. N. Fought)

synchronous motors bring the motion of the equatorial axis to the right ascension and declination dials, but the motion of the roof is transmitted through a train of gears to its dial. The motions of the flat and of the roof are completely controlled by a set of push buttons on and near the panel. The operation of the telescope is the nearest approach to the "blind flying" of the aviator that most astronomers ever make, with the great difference that the successful operation of the telescope is amazingly easy and certain. In addition to the ordinary types of motion which have been mentioned, the eyepiece of the telescope rotates at the proper rate to eliminate the rotation of the field caused by the single reflection siderostat.

Except for the fifteen-inch objective, the horizontal telescope was made entirely by the J. W. Fecker Company. The objective lens and an accompanying photographic corrector were made by the John A. Brashear Company for the Philadelphia Central High School, but was

never used. The visual focal length is seventeen feet ten inches. The optical flat which feeds the fifteen-inch is twenty-six inches in diameter and is made of low expansion glass. An auxiliary telescope of seven and one-half inches aperture, with the same focal length as the larger lens, and intended for use as a guiding telescope, is mounted by the side of the main telescope. The guiding telescope has its own individual flat of eight inches diameter. The telescope was designed and built for sight-seeing in the skies and one of the cleverest aids to its necessary ease of manipulation is a device constructed by Mr. Cook which makes the changing of eyepieces as easy as turning the leaves of a book. All of the eyepieces and the double-slide plate holder are interchangeable between the reflector and the horizontal telescope.

A three-inch "broken" transit is housed in the same building with the reflector and the refractor. The mounting of the optical parts is entirely the work of Mr. Cook and it is remarkable for the skillful and economical design eliminating the unnecessary and trifling adjustments which often make such instruments tiresome in practice. Mr. Cook also has made a chronograph to supplement his transit, but as is the custom among astronomers, the clocks (there are seven clocks in the Star House) are set by comparison with Arlington time signals.

Photographs of the sun have been made for some years at the Roslyn House Observatory with a horizontal telescope having a focal length of forty feet. Lundin made the photographically corrected six-inch lens which is used in the instrument. The light from the sun is reflected into the lens from an unsilvered optical flat. The flat has an equatorial mounting and is driven by a synchronous motor at one-half of the mean solar rate. Such a drive is not very accurate, but it is sufficiently good for the practically instantaneous exposures to the sun. In ordinary use the lens is stopped down to two inches aperture and in conjunction with a focal plane shutter the exposure is less than five thousandths of a second. The camera end of the telescope is a small room in the Sun House. There is no telescope tube connecting the lens and the camera. The path of the light from the lens is across well-sodded ground and the convection currents are small and not troublesome. The spectrohelioscope which shares the Sun House with the solar camera has been in operation since 1930 but has had little use during the sun-spot minimum. The instrument is the standard construction of Howell and Sherburne of Pasadena, California. The glass coelostat mirrors can be replaced by stainless steel flats which have been very satisfactory in use.

It is never easy to keep silver-on-glass mirrors in first class condition and the ordinary deterioration of the silver coating is hastened at this observatory by the excessive humidity which prevails during the late summer and early autumn months. In spite of great care, it is almost impossible to prevent the regular fogging of the mirrors in the early morning hours. As a consequence, the J. W. Fecker Company has under construction an apparatus for aluminizing mirrors of forty inches diameter or less. This apparatus will be set up at the Roslyn House

Observatory and it is expected that an aluminum reflecting surface will be reasonably long lived.

With the instrumental equipment sketched above available, the chief difficulty involved in instituting a research program lay in deciding what line of work should be followed, for an investigation in almost any branch of astronomy might be undertaken, with the exception of an astrometric research. Dr. J. A. Miller of the Sproul Observatory, who is responsible for the beginning of systematic observation at Roslyn House, suggested that since the program of Sproul Observatory has been devoted almost entirely to the determination of trigonometric parallaxes, the types of research at the two institutions could be made completely complementary. As the program has been developed, each observatory carries on different lines of investigation so that in the combination of the two, research in progress represents the three divisions of modern observational astronomy: astrometry, photometry, and spectroscopy. Sproul Observatory has added photoelectric photometry to its well established astrometric program, and at Roslyn House Observatory work has been begun in photographic spectrophotometry, under the direction of Dr. Orren Mohler. He has been personally responsible for the adjustment and modification of the instruments where necessary; the planning and execution of the observing program, and the measurements of the plates obtained.

The twenty-eight and one-half inch reflector and the two-prism spectrograph are being used in the Roslyn House program. As in use at present, the spectrograph with the nine-inch camera gives a dispersion of 49.8 angstroms per millimeter at $H\gamma$. Usable spectra of sixth magnitude A0 stars require a one hour exposure on Imperial Eclipse plates. It is, of course, not expected that the spectra of faint stars will be studied. On the observing program are the brighter emission line stars, which are tantalizing objects for spectrophotometry; and bright stars with broad lines showing variable radial velocity for which no spectroscopic orbits have been determined. The radial velocities of the broad line stars are being measured with a photoelectric densitometer, a method which leads to greater consistency in the derived velocities than is usually obtained. Through the courtesy of Dr. W. F. G. Swann, the Koch densitometer of the Bartol Research Foundation of the Franklin Institute is being used for studying the spectrum photographs.

Most amateur astronomers might feel satisfied with equipment and a program such as that at Roslyn House, but Mr. Cook has a photoelectric stellar photometer, sensitive in the infra-red, under construction for use on the fifteen-inch horizontal telescope. Observers who have used photoelectric cells will appreciate the advantages offered for this type of research by a telescope with a fixed eyepiece. Dr. John S. Hall of the Sproul Observatory is directing the construction of the photometer, and the instrument will embody some new features. Measures will be made of the variation of the infra-red light of the brighter variable stars and it is hoped that a program of simultaneous spectrographic

and photoelectric measures can be carried out. Mr. Cook intends to use this photometer personally and by undertaking this research places his observatory among the first three in the world to make such observations.

THE OBSERVATORY, ROSLYN HOUSE, WYNNEWOOD, PENNSYLVANIA,
1934, NOVEMBER.

Lunar Saros Series

By ALEXANDER POGO

The 5200 lunar eclipses included in the 2nd part of Oppolzer's *Canon der Finsternisse*[1] cover more than three millennia (from 1207 B. C. to A. D. 2163), an interval sufficiently long to justify certain statistical investigations; these 5200 eclipses belong to 139 saros series,[2] 80 of which are completely within the limits of the *Canon*. The diagram reproduced in Figure 1 represents the 3093 lunar eclipses which occurred between —499 May 4 and 1501 October 26; they belong to 93

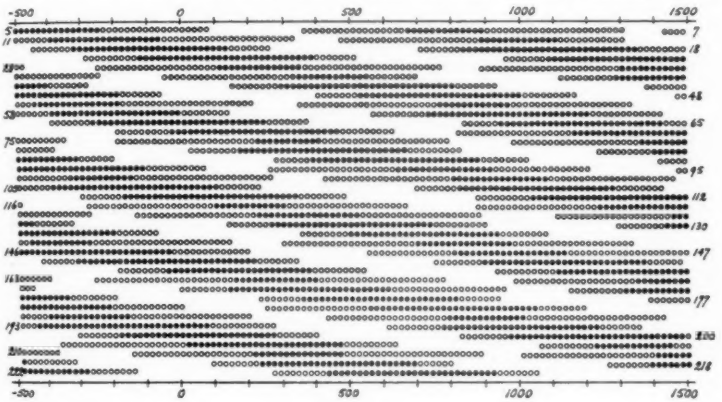

FIGURE 1.
SAROS SERIES OF LUNAR ECLIPSES, 500 B. C. TO A. D. 1500.

saros series, 39 of which are completely within the limits of the diagram; 29 series are truncated by the left edge, and 25 series by the right edge of the diagram. The last two columns of Table IV list the 30 lunar saros series which were running during the first 18-year interval of the VIIth century of our era; these 30 saros series are plotted in the diagram of Figure 2.

The present investigation is based, chiefly, on the 80 complete saros

[1] Denkschriften d. Akademie, math.-naturwiss. Cl., Bd. 52, Wien 1887.

[2] A saros series, identical with the Saros-Zyklus of the Germans, is a series of eclipses occurring, under slowly changing circumstances, at intervals of 6585.3 days. The exeligmos of the Greeks is a triple saros, an interval of 19756 days.

series mentioned above, and covers about thirty-two centuries, from the beginning of series L 81 (—1142 June 2) to the end of series L 42 (2064 July 28). In the beginning of the *Canon*, there are 29 truncated ("beheaded") series, while at the end there are 30 truncated ("tailless") ones; an investigation of these 59 incomplete series was made, in order to check the statistical results obtained from the 80 complete series, and these results were confirmed in every respect; the present paper represents, therefore, in a broader sense, the results derived from a study of

100 runs (p') of initial partial eclipses
99 runs (t) of total eclipses
100 runs (p'') of terminal partial eclipses

of the moon, and of

110 dates (P') of first partial eclipses
110 dates (T') of first total eclipses
109 dates (T'') of last total eclipses
109 dates (P'') of last partial eclipses

of lunar saros series.

Some of the "beheaded" lunar saros series (*e.g.*, L 169, L 69, L 210, L 116, and L 122) are important from the point of view of the history of Mesopotamian-Mediterranean chronology and astronomy; eclipses belonging to such series and mentioned in the *Almagest* include carefully observed inconspicuous P'' eclipses (*e.g.*, the last eclipses of L 69 and L 116, respectively), obviously selected by Ptolemy or his predecessors from tables of lunar saros series; these matters will be dealt with elsewhere.

Of the 80 complete lunar saros series, 50 belong to the minor, and 30 to the major type; this 5-to-3 ratio is a result of the truncation process which discriminates in favor of minor series—the true ratio is somewhat closer to "parity"; the relative frequency of the two types of series will be discussed in another paper, in connection with the fluctuations of the number of lunar saros series running simultaneously.

The first characteristic feature of the two types of series is their duration, or the number n of eclipses they contain: see Table I. There may

TABLE I

VALUES OF p', t, p'', AND n.

		—Short runs— min.	max.	mean	—Long runs— min.	max.	mean
Runs of total ecl.	t	11	19	14	22	30	27
Runs of partial ecl.	p' or p''	6	13	8	14	23	21
Lunar saros series	$p'+t+p''=n$	39	49	43	53	59	56

be from 39 to 49 eclipses in a minor lunar series, and from 53 to 59 in a major one; the average values are 43 and 56, respectively; the duration of a minor series varies from 685 to 865 years, while a major one may run from 937 to 1046 years. This first characteristic feature, the length of the run, or the value of $p'+t+p''=n$, permits us to assign the hybrids to their proper types.

The second characteristic feature of the two types of lunar saros

series is their composition, or the relative length of the p', t, and p'' runs. A minor series consists of one long and two short runs; in a pure series of this type, the run of total eclipses, t, is long; in a hybrid minor series, t is short, and one of the partial runs, p' or p'', is long. A major series consists of one short and two long runs; in a pure series of this type, the run of total eclipses, t, is short; in a hybrid major series, t is long, and one of the partial runs, p' or p'', is short. In other words, the two types and their hybrids are characterized by the average values of the ratios of total and partial eclipses listed in Table II.

TABLE II

AVERAGE RATIOS OF TOTAL AND PARTIAL ECLIPSES.

	Minor series		Major series	
	pure	hybrid	pure	hybrid
$\frac{t}{p'+p''}$	1.7	0.4	0.3	0.9
$\frac{t}{\frac{n}{p'+p''}}$	0.6	0.3	0.25	0.5
$\frac{\frac{n}{p'+p''}}{n}$	0.4	0.7	0.75	0.5

Hybrids are rare among minor series, and relatively frequent among the major ones; 46 of the 50 complete minor series, or 92 per cent, are pure; on the other hand, but four out of five complete major series, or 80 per cent, are pure.

The third characteristic feature of the two types and of their hybrids is the seasonal distribution of the runs of total and partial eclipses, *i.e.*, the location, on the ecliptic, of the dates P', T', T'', and P''. The results derived from the investigation of the 80 complete series are given in Table III. A tabulation of the results based on the 59 truncated series confirms the assumption that neither the "creeping" of the Julian months through the seasons nor the shift caused by the Gregorian reform could affect the general conclusions derived from little more than three millennia of lunar eclipses. A glance at Table III shows that the region of the ecliptic, where the first eclipse of a partial or total run occurs, determines the length of the run, and, therefore, the type and purity of the series to which the run belongs. In the perihelion arc of the ecliptic, the duration and magnitude of the consecutive eclipses of a given series vary very slowly; this "hibernation" produces the long runs of partial eclipses of the pure major and of the hybrid minor series, as well as the long runs of total eclipses of the pure minor and of the hybrid major series. These matters will be dealt with in other papers, in connection with lunar exeligmos curves, the period of 595 years less one week (11 exeligmoi = 33 saroses = 7359 lunations), the seasonal rate of variation of the duration and magnitude of eclipses, the frequency of lunar appulses, and related subjects. It might be mentioned here that the lunar exeligmos curves reveal, more clearly than does Table III, the genesis of the pure and hybrid series of the two types.

TABLE III

DISTRIBUTION OF THE DATES P', T', T'', AND P''.

50 Minor Saros Series

	First partial		First total		Last total		Last partial	
	pure	hybr.	pure	hybr.	pure	hybr.	pure	hybr.
January	1	.	.	.	1	.	.	.
February	5	1	.	2	2	.	.	.
March	7	.	.	1	6	.	.	.
April	9	.	.	.	12	.	.	.
May	12	.	4	1	16	.	3	.
June	12	.	12	.	8	1	12	1
July	.	2	12	.	1	2	12	.
August	.	1	10	.	.	.	12	.
September	.	.	6	.	.	.	3	1
October	.	.	2	.	.	1	2	.
November	.	.	.	.	.	.	2	2
December	.	.	.	.	.	.	.	.

30 Major Saros Series

	First partial		First total		Last total		Last partial	
	pure	hybr.	pure	hybr.	pure	hybr.	pure	hybr.
January	.	.	2	.	.	3	.	1
February	.	.	2	.	.	.	3	1
March	.	.	6	.	.	1	7	.
April	.	.	10	.	.	.	11	.
May	.	.	3	4	.	.	2	4
June	1	1	.	.	1	1	1	.
July	9	1	.	.	5	1	.	.
August	7	.	.	.	10	.	.	.
September	5	2	.	1	5	.	.	.
October	2	.	.	1	2	.	.	.
November	.	2	.	.	1	.	.	.
December	.	.	1	.	.	.	.	.

The diagram reproduced in Figure 1 could be transformed into a three-dimensional one, by mounting it on a cylinder in such a manner that the saros series L 223 (bottom, center) should coincide with the

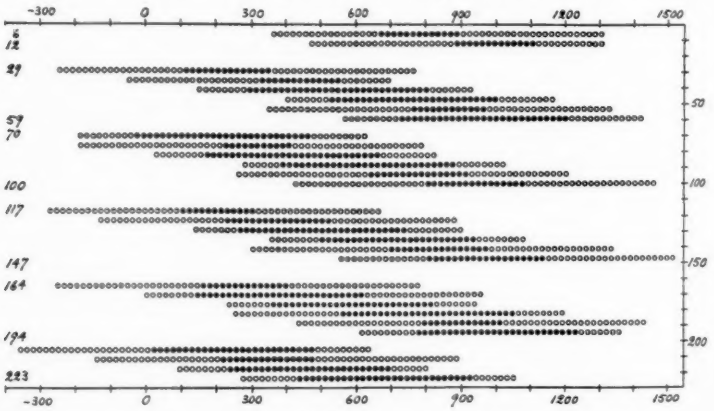

FIGURE 2.

FIVE GROUPS OF SIX LUNAR SAROS SERIES.

zero-lunation line (top); the 3093 eclipses of this three-dimensional diagram would form 111 windings of a spiral around the cylinder. The diagram of Figure 1 was, of course, obtained by plotting the points P', T', T'', and P'' as abscissae and the lunations of the corresponding series as ordinates; it is, however, useful to think of it as of a string of successive eclipses wound around a cylinder, the pitch of the windings corresponding to 6585.3 days; by detaching this string of successive

TABLE IV

LUNAR ECLIPSES OF 18 CONSECUTIVE YEARS, AND THE CORRESPONDING SAROS SERIES.

Lunations	Node	Nodical months	Latitude	Lunar eclipses of 18 consecutive years	Magnitude	Number of eclipses in saros series $p'+t+p''=n$	Type of series
6	A	6½	S	601 Mar 24.5	6.9	17+13+23=53	maj
12	D	13	S	601 Sep 17.9	8.1	23+13+11=47	min., hyb
	A						
	D						
29	A	31½	N	603 Feb 1.9	9.1	20+14+23=57	maj
35	D	38	S	603 Jul 28.8	7.0	21+13+ 8=42	min., hyb
41	A	44½	N	604 Jan 22.6	21.3	8+29+ 7=44	min
47	D	51	S	604 Jul 16.9	20.1	7+27+ 9=43	min
53	A	57½	N	605 Jan 11.1	4.9	23+12+20=55	maj
59	D	64	S	605 Jul 6.3	4.0	9+27+12=48	min
	A						
70	D	76	S	606 May 27.7	1.9	9+28+ 9=46	min
76	A	82½	N	606 Nov 20.5	3.6	23+11+21=55	maj
82	D	89	S	607 May 17.4	17.8	8+28+ 9=45	min
88	A	95½	N	607 Nov 9.6	19.9	6+28+ 8=42	min
94	D	102	S	608 May 5.8	9.9	21+16+16=53	maj
100	A	108½	N	608 Oct 29.1	9.6	21+16+21=58	maj
	D						
	A						
117	D	127	N	610 Mar 15.4	5.0	21+12+20=53	maj
123	A	133½	S	610 Sep 8.9	6.4	20+17+20=57	maj
129	D	140	N	611 Mar 4.7	22.2	7+27+ 9=43	min
135	A	146½	S	611 Aug 29.2	22.0	8+25+ 8=41	min
141	D	153	N	612 Feb 22.3	7.2	22+16+20=58	maj
147	A	159½	S	612 Aug 17.2	5.4	14+19+21=54	maj
	D						
	A						
164	D	178	N	614 Jan 1.9	7.6	23+14+21=58	maj
170	A	184½	S	614 Jun 27.3	12.1	8+27+19=54	maj., hyb
176	D	191	N	614 Dec 22.1	21.3	7+26+ 7=40	min
182	A	197½	S	615 Jun 16.9	17.0	17+28+ 8=53	maj., hyb
188	D	204	N	615 Dec 11.0	6.5	20+13+23=56	maj
194	A	210½	S	616 Jun 5.7	0.3	9+26+ 7=42	min
	D						
205	A	222½	S	617 Apr 26.7	3.3	21+26+ 9=56	maj., hyb
211	D	229	N	617 Oct 20.1	5.5	20+15+23=58	maj
217	A	235½	S	618 Apr 15.8	19.5	8+26+ 6=40	min
223	D	242	N	618 Oct 9.7	20.7	9+28+ 7=44	min

eclipses from the saros cylinder, and by winding it around other cylinders of appropriate diameters, it is easy to visualize, in three dimensions, various other diagrams of the same nature. Thus, if the Metonic cycle (235 lunations) or the Maya eclipse cycle (Mec = 405 lunations) were substituted for the 223-lunation pitch of the saros windings, diagrams could be obtained which would give, at a glance, the patterns formed by groups of eclipses separated by prescribed intervals. The Mec diagram and its use in the study of the Dresden Codex will be discussed elsewhere. In my paper on the calendar years with seven eclipses, I shall return to the Metonic cycle; it may be noticed, incidentally, that the Metonic pattern is represented, in the lunar saros diagram of Figure 1, by a move of the knight in chess: a step from one winding to the next corresponds to 18 years and 10 days (223 lunations), while a double step in the direction of successive eclipses of a winding represents 1 year less 10 days (12 lunations); thus, eclipses separated by 19 years (235 lunations), fall on the same calendar date, and are joined, in the saros diagram, by a move of the knight; the importance of the Metonic-pattern "jump" over the blank diagonals of the saros-series diagram will become apparent in a later paper.

The diagram reproduced in Figure 1 shows that the lunar saros series form diagonal groups, the consecutive series within each group or ribbon being separated by 6 lunations. Beginning with the left-hand upper corner of the diagram, we have the diagonal ribbon consisting of the series

L 5, L 11, L 17, . . . [L 221, L 4, L 10];

it is preceded by the diagonal ribbon containing the series

L 4, L 10, L 16, . . . [L 220, L 3, L 9];

and it is followed by the diagonal ribbon formed by the series

L 6, L 12, L 18, . . . [L 222, L 5, L 11].

The series in brackets belong to the distant future; on our saros cylinder, the diagonal ribbons would correspond to 5 spirals having a period of the order of six thousand years; the only practical value of these theoretical considerations is the realization of the shortness of that section of our cylinder which is covered by the saros series formed by the string of lunar eclipses of the historical past and of the near future.

The relative frequency of minor and major lunar saros series may be mentioned, once more, in connection with the diagrams of Figures 1 and 2. The 39 complete series of the first diagram consist of 24 minor and 15 major series, and lead to a ratio of 1.6; if we take into consideration the 54 series truncated by the diagram (41 of these are complete within the *Canon*, and the type of most of the others is clearly shown by the available data), the ratio is lowered to about 1.5. On the other hand, the approximate "parity" of the minor and major series of the second diagram is upset, in favor of the minor series, by the trimming of the diagram at both ends.

The pattern of the saros series represented in Figure 1 shows that the usual number of consecutive eclipses varies from 4 to 6; the unusual group of 12 consecutive eclipses between 878 April 20 and 883 July 23 was due to the coalescence of two groups of six eclipses; incidentally, the 10 consecutive eclipses between 878 October 15 and 883 January 27 were visible in the Maya territory.

The normal pattern of groups of six eclipses is shown in Table IV and in the diagram of Figure 2. The saros series of the eclipse of 600 September 28 was chosen as the zero-lunation series, and the reasons for this choice will be given in a forthcoming paper. The 1st and 3rd columns of Table IV show a typical syzygy-table arrangement of synodical and nodical months, counted from a total eclipse; column 2 indicates the nodes at which the eclipses of the corresponding saros series occur; these three columns of Table IV thus refer both to the individual eclipses listed in column 5 and to the saros series summarized and classified in columns 7 and 8; on the other hand, columns 4 and 6 refer to the individual eclipses of column 5 only; they serve to illustrate the seasonal variations of the terrestrial latitude, in the tropics, pierced by the axis of the umbra, and a typical succession of total and partial eclipses of 18 consecutive years. The diagram of Figure 2 shows the five groups of six saros series corresponding to Table IV; on a cylindrical diagram, the saros series L 223 (bottom) would precede, by six lunations, the saros series L 6 (top).

The total eclipse of the moon of 1935 January 19 belongs to a minor series, L 1, running since 1520 May 2; the total eclipse of 1935 July 16 belongs to a major series, L 7, running since 1430 September 2; I shall return to these two series in a forthcoming paper.

I wish to express my thanks to Miss V. Peterson, of the Yerkes Observatory, who made part of the computations illustrated by the diagrams of Figures 1 and 2.

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Washington, D. C.
January 19, 1935.

Theories of Long-Period Variable Stars

By PAUL W. MERRILL

(Seventh Paper)*

My first duty in writing this article is to admit that astronomers do not know the underlying cause of the great fluctuations of the light of long-period variables. Much can be said about *how* these stars vary; little, with certainty, about *why* they vary. The statement is true also of sun-spots and numerous other astronomical objects.

Extensive observations of the positions of planets by Tycho Brahe about 1600 laid the necessary foundation for Kepler's great laws of planetary motion and these in turn made possible Newton's later enunciation of the inverse-square law of gravitation. The study of variable stars is still in the Tycho Brahe stage; a few generalizations (such as "the redder the star the longer the period" or the so-called period-luminosity law) may perhaps in a measure correspond to Kepler's contribution but Kepler's part is far from complete and Newton is apparently a long way off. It is probable that much more observing and a more detailed organization of the data must precede the formation of a comprehensive theory of long-period variables.[1]

The egregious weakness of many of the older theories is the assumption that the variables behave like partially solid or liquid bodies rather than gases of very low density. This fact lessens the consideration we might otherwise give to certain ingenious hypotheses. A few suggestions made many years ago deserve mention, however, not only for their historical interest but because they may yield valuable ideas for current investigations.

Axial Rotation

The axial rotation of a spotted star was early mentioned as an explanation of stellar variability. With an arbitrary arrangement of bright and dark areas, almost any light curve may be reproduced, but in a tenuous star the necessary discontinuities probably could not exist for hundreds of cycles as would be necessary to account for the observed light curves of *o* Ceti and other well-known variables. Moreover, the amplitude of the light curve would depend on the orientation of the

*For preceding papers, see February, May, and October (1929), March (1931), April (1933), and April (1934) issues.

[1] I find, to my surprise, that not every one believes in this method of approach. An astronomer has written that the spectra of long-period variables "have been extensively and perhaps too minutely studied." Numerous detailed facts may indeed be stumbling blocks to the hop, skip, and jump investigator and to the scientist who must maintain the appearance of solving with great expedition every problem he takes up; but the history of science shows, I believe, that as much progress has resulted from the observational investigation of curious details as from the intellectual manipulation of generalities.

axis of rotation with respect to the earth, and observed correlations with period, spectrum, and behavior of bright lines would remain unexplained. A modern version of the rotation theory appears in the suggestion by Sir James Jeans that changes in brightness depend on the rotation of a pear-shaped body. Neither this explanation (which may apply to such an object as β Lyrae) nor any other in which geometrical *orientation* plays a leading role seems readily to explain certain typical features of long-period variables, notably their large light ranges (many are 100 times as bright at maximum as at minimum, some more than 1000 times), the irregularities of range and phase in the light curve, the observed correlations of period and spectral peculiarities with amplitude, and the behavior of bright lines during each cycle.

Internal Circulation

While the rotation of a star as a whole seems inadequate to explain long-period variability, the circulation of the gases beneath the surface may possibly be of fundamental importance. The discussion by Bjerknes of possible internal currents in the sun in their relation to sun-spots and other solar phenomena is well known; in a very interesting paper Svein Rosseland[2] has suggested that similar ideas may have an important application to variable stars.

> "The spots are presumably secondary phenomena which are generated and controlled by the large scale internal circulating currents in the sun. The close study of these circulating currents is, I believe, the fundamental problem of stellar variability."

According to Rosseland his ideas "lead to a view intermediate between the pulsation and rotation theories."

The idea of a general analogy between the cycles of variable stars and the eleven-year period in the frequency of sun-spots is, of course quite old. Interesting references may be found in Frost-Scheiner, *Astronomical Spectroscopy*, pp. 308, 311, and Agnes Clerke, *Problems in Astrophysics*, p. 362.

The "geyser" or "crust-struggle" theory is outlined by W. W. Campbell[3] as follows:

> "It is not impossible that in this star (o Ceti) and others of the very red stars, there is a struggle to form a crust over the surface. As the crust forms and covers an increasing proportion of the solar surface, the light must diminish; and it is not unreasonable to suppose that the imprisoned gases and vapors immediately below the crust increase in temperature and pressure, so that when a certain point is reached the crust is broken through, and destroyed, and the brightness of the star thenceforth increases rapidly, up to maximum. If this is really the case, it would not be surprising to have the lighter elements, such as hydrogen, projected outwardly from the star's surface with great speed."

Present data on the sizes and probable densities of long-period variables make it impossible longer to postulate the formation of a solid crust, but the general ideas of the instability and relative motions of

[2] *On Sun-Spot Activity and Stellar Variability*, Avhandlinger utgitt av Det Norske Videnskaps-Akademi, Oslo, I Mat.-Naturv. Klasse 1929. No. 6.

[3] *Stellar Motions*, p. 303, Yale University Press, 1913.

certain luminous gases are not invalidated. Moreover, if in the above quotation we substitute for "crust" a cloud-like upper veil we have a mechanism which should not be ignored as a partial explanation of the light changes of long-period variables.

Although a complete theory is not now within our grasp, certain phases of the problem of long-period variables present attractive opportunities for careful study. It is decidedly worth while, for example, to go as far as we can toward forming a picture of what actually takes place in a variable, even if, for the time being, we remain in ignorance of what started the process or how it keeps going. In general, the most favorable point of attack at present would seem to be the physical characteristics of the variables and the detailed nature of their fluctuations rather than the evolutionary or historical background.[4] Extensive photometric and spectroscopic data offer suggestion and guidance. Certain partial explanations, not yet thoroughly exploited, are of much interest; it seems safe to say that some of them will certainly play a rôle in any future comprehensive theory.

Most astronomers consider it probable that the active cause of long-period variability lies within each star, and consists essentially of some sort of an energy oscillation about a mean condition of stability.[5] Interchanges of various forms of physical and chemical energy are conceivable. Geometrical pulsations may or may not be involved; in considering their probability we naturally think of Cepheid variables. Volume pulsation, although by no means firmly established, seems by a process of elimination to have become the most favored (or the least objectionable) theory of Cepheid variation. It is therefore pertinent to inquire what would be the period of a volume pulsation in a long-period variable. Eddington[6] has seen fit to turn the problem about, and to compute, on the basis of his theory of the internal constitution of the stars, the diameter of a long-period variable having a period of 300 days and a mass ten times that of the sun. He finds approximate agreement with values determined in other ways and concludes that "the dimensions are accordingly consistent with the hypothesis that the period of about 300 days is that of the natural pulsation of the star." The light curves and spectra of long-period and Cepheid variables differ radically. In fact about the only feature in which the two types of variables resemble each other is the rapid rise to maximum light followed by a slower decline. The burden of proof is therefore clearly upon those who would explain both types of variables by the same mechanism.

The physical effects which may act as immediate causes of the changes in brightness of long-period variables will now be briefly discussed. Those most deserving of consideration appear to be:

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[4] This will be briefly considered in the next paper.

[5] Suggestions of other kinds are not lacking but they do not appear plausible or compelling.

[6] *Internal Constitution of the Stars*, p. 208.

1. Change in effective photospheric temperature.
2. Change in band absorption.
3. Veiling.

One or more of these effects may be part of the *modus operandi*, whatever the fundamental cause that started the variation or keeps it going. The three phenomena are not, of course, mutually exclusive; on the other hand it is entirely probable that two or more of them may act together.

Brightness as Dependent on Temperature of the Photosphere

At the low effective temperatures of these red variables a considerable decrease in total radiation and a still larger decrease in visual brightness results from a small decrease in temperature. Table I shows the change in total radiation and in brightness of a black body through a range of several hundred degrees below 2300° C (absolute), a temperature representative of long-period variables at maximum light.

TABLE I

Dependence of Total Radiation and Visual Brightness on Temperature

T	—Total Radiation— Rel. Value	Δ mag.	—Visual Brightness— Rel. Value	Δ mag.
2300°	1.00	0.00	1.00	0.00
2200	0.84	0.19	0.62	0.52
2100	0.70	0.40	0.36	1.09
2000	0.57	0.61	0.20	1.72
1900	0.47	0.83	0.11	2.42
1800	0.38	1.06	0.053	3.19
1700	0.30	1.31	0.024	4.05
1600	0.23	1.58	0.0098	5.02
1500	0.18	1.86	0.0036	6.12

According to Pettit and Nicholson[7] "on an average the temperatures (of six long-period variables) range from a minimum of 1800° to a maximum of 2350°, the phases agreeing nearly with the corresponding phases of light. The coolest star of type Me so far observed is χ Cygni, which varies from 1630° to 2260°." They found the mean energy range to be 1.0 magnitude, corresponding to a visual range of 5.9 magnitudes. From Table I it is found that a drop in temperature from 2300° to 1830° corresponds to a decrease of 1.0 mag. in total radiation and of 3.0 mag. in brightness. Hence 2.9 mag. (5.9 — 3.0) are left to be accounted for by band absorption, veiling, or some other process.

At 2300° the wave-length of maximum intensity in the spectrum of a black body lies at 12,560 A in the infra-red; at 1800° it recedes to 16,060 A. On the short wave-length side of the maximum, the decrease in intensity upon cooling from 2300° to 1800° becomes progressively greater toward the ultra-violet. The actual amounts for various wave-lengths are shown in Table II. It is interesting to note that while the change in visual brightness (calculated from the intensities at 5900 A)

[7] *Mt. W. Contr.*, No. 478; *Ap. J.*, **78**, 320, 1933.

is 3.2 mag., at 4000 A the change in intensity is 4.7 mag; at 9000 A in the infra-red only 2.1 mag.

TABLE II

CHANGE IN INTENSITY AT VARIOUS WAVE-LENGTHS OF BLACK-BODY RADIATION FOR A DECREASE IN TEMPERATURE FROM 2300° TO 1800°

Wave-length	——Change in Intensity—— Rel. Val.	Δ mag.
10,000 A	0.18	1.88
9,500	0.16	1.98
9,000	0.15	2.09
8,500	0.13	2.21
8,000	0.11	2.35
7,500	0.099	2.51
7,000	0.084	2.69
6,500	0.069	2.90
6,000	0.056	3.14
5,500	0.043	3.42
5,000	0.031	3.76
4,500	0.021	4.18
4,000	0.013	4.71
3,500	0.0071	5.38
3,000	0.0031	6.27

C. W. Hetzler[8] has recently reported that measurements with the Thaw refractor at Allegheny Observatory show that for several long-period variables "the magnitude range in the infra-red (about 8600 A) seems to be one-third to one-half that in the visual," and that for χ Cygni and R Aquilae the observed ranges approximate those computed from the probable temperatures at maximum and minimum. Table II shows that a typical long-period variable, if it radiates like a black body, should have a range in visual magnitude about 50 per cent larger than that at 8600 A, whereas Hetzler's observations show it to be two or three times as great. His observations, therefore, as well as those of total radiation, indicate that some other cause than change in effective temperature must operate to produce the large visual ranges.

EFFECT OF ABSORPTION BANDS

Variables of classes M and N have heavy band absorption in the visual region which must appreciably reduce their brightness. In the M-type variables it seems evident from inspection of spectrum photographs extending from 3900 A to nearly 9000 A that the bands are particularly effective between 4500 A and 6400 A, although the bordering regions 4200 A to 4500 A and 6400 A to 7800 A contain bands of less absorbing power.[9] Joy's comparison of the spectrum of o Ceti with that of a K5 star[10] yielded an approximate value of 1.9 mag. for the reduction in the visual brightness at time of maximum light due to band absorption. Additional evidence of special absorption of visible light

[8] *Pub. Am. Astron. Soc.*, **8**, 13, 1934.

[9] In the infra-red, bands of considerable intensity occur at 8440 A and 8860 A. *Mt. W. Contr.*, No. 486; *Ap. J.*, **79**, 183, 1934.

[10] *Mt. W. Contr.*, No. 311; *Ap. J.*, **63**, 281, 1926.

is offered by the relatively low temperatures computed by Pettit and Nicholson from their determinations of heat index.[11] The temperature is computed by comparing the visual magnitude with the intensity of the total radiation measured with a thermocouple, on the assumption that the spectral energy curve is that of a black body. If the energy curve is lowered in the visual region (more than elsewhere) by band absorption, the computed temperatures will be too low. In the problem of variable stars, however, we are concerned only with the *change* in absorption from maximum to minimum. Spectrophotometric measurements are badly needed to give quantitative data concerning this effect. Joy thinks that for o Ceti the differential effect from maximum to minimum may be of the order of two magnitudes.

The effects of band absorption on the colors and magnitudes of stars of classes M and N, as well as the possibility that changes in band absorption may account for a considerable part of the changes in brightness of variables of these classes, have been discussed by Cecilia H. Payne and P. ten Bruggencate.[12] The conclusion by Miss Payne and Frank S. Hogg[13] that in the spectrum of o Ceti "The bands of titanium oxide cut off only about twenty per cent of the photographic light of the star when it is at maximum," is based on the assumption that the continuous spectrum just to the violet of the main band-heads suffers no band absorption at all. This assumption may be far from the truth, and the actual absorption therefore considerably more than twenty per cent.

Veiling

A third phenomenon which may increase the light ranges of long-period variables is the formation of a cloudy veil of liquid particles condensed, at certain phases, from gases of the upper atmosphere. The existence of such a cloud is suggested by the low temperature of the photosphere and reversing layer; by the surprisingly small variation in detail which a spectrum sometimes exhibits while the star is undergoing a considerable change in magnitude; and by the apparent insufficiency of other hypotheses.

The photospheric temperature is well below the terrestrial boiling points[14] of many fairly common substances and even at the low pressures prevailing in stellar atmospheres, Rupert Wildt[15] has shown that in the coolest stars condensation of compounds of low volatility is probable. The clouds would be fairly stable according to his calculation, because the velocity of fall of the individual droplets would be small. Wildt has recently suggested[16] that convection caused by dissociation of hydrogen molecules may play an important role in the

[11] *Mt. W. Contr.*, No. 369; *Ap. J.*, **68**, 279, 1928.
[12] *Harvard Bulletin* No. 876.
[13] *Harvard Circular* No. 308.
[14] The boiling point decreases with the pressure.
[15] *Zeit. f. Astrophysik*, **6**, 345, 1933.
[16] *Ibid.* **9**, 176, 1934.

atmospheres of long-period variables.

Veiling appears to be a good explanation for a considerable change in magnitude unaccompanied by appreciable changes in the details of the dark-line spectrum. Every spectroscopic observer of long-period variables must have noticed this phenomenon. Miss Dorothy N. Davis[17] remarks as follows upon its presence in certain S-type variables: "The brightness of R Canis Minoris, for example, changes by almost three magnitudes but the appearance of the spectrum (aside from the bright lines) changes so little that the change nearly escapes detection. Another example is furnished by comparison of the spectra of R Cygni and R Geminorum. These stars have practically identical spectra at maximum, but outside of maximum phase, the spectrum of R Cygni shows much more rapid change." Similar comparative studies of numerous other variables would probably be worth while. Apparently the rate of change in the appearance of the spectrum or the amount of change per magnitude is not the same in all variables of the same type.

The mean range of variables of advanced M-type spectra is about six magnitudes. If we subtract three magnitudes for the effect of changing temperature and two magnitudes for differential band-absorption,[18] there remains one magnitude yet unaccounted for. Moreover it is a rather striking fact that in certain variables of class S without strong bands the light range is as great or greater than in variables of class M. Veiling, therefore, may be of relatively greater importance in the class S variables. Another interesting fact, in this connection, is that χ Cygni, whose spectrum combines very strong titanium bands with features of class S, has perhaps the largest range of any star in the sky.

The effect of the cloudy veil upon the color of the star depends on the size of particles. For relatively large particles whose diameters are, say, 0.001 mm or more, the veil is neutral, all visible wave-lengths being cut down equally. For diameters about 0.0003 mm the absorption has a maximum in the near infra-red and decreases toward the ultra-violet, causing the star to appear slightly less red. If the diameters are 0.0001 mm or less, the maximum lies in the ultra-violet with the losses decreasing toward the red, so that the photospheric light is reddened. The effect may be very marked; for example, if the diameters are less than 0.00005 mm, the scattering varies inversely as the *fourth* power of the wave-length (Rayleigh's law). It is this effect that gives us the blue sky and red sunsets. For diameters 0.00013 to 0.00025 mm the maximum lies in the visible spectrum, the losses decreasing slowly toward the red, more rapidly toward the violet; and the effect on the color would probably be small.

Modified veil theories embodying atmospheric convection have been discussed by J. Hopmann[19] and by H. Thomas.[20]

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[17] *Pub. A. S. P.*, **46**, 267, 1934.

[18] This amount may be too large.

Remarks Concerning Bright Lines

A convincing explanation of the presence of emission lines in the spectra of long-period variables has not yet been made. In particular the origin of the very intense hydrogen lines remains a mystery. The atomic relationships of these lines show that they cannot be emitted unless the hydrogen atoms are strongly excited. The photosphere is not hot enough to supply the required excitation and no other source of sufficient energy is obvious.

The behavior of the bright lines may, however, offer useful hints in the formation of a general theory of long-period variables. One suggestion is that, because of the large size of these stars or the low densities of their atmospheres, or for other reasons, various spectroscopic phenomena are not closely interrelated, but may proceed in partial independence of each other. The temperature of the photosphere, for example, appears not to have immediate control over the appearance and intensity of the bright lines. It seems rather as if the brightening of the photosphere were but one of a number of phenomena set going by a special occurrence at a certain phase. To illustrate the idea, let us postulate a release of energy in a certain level at intervals of time equal to the period of light-variation. These occur presumably just before minimum. The first visible result is the brightening of the continuous spectrum, caused either by an increase in the radiation of the photosphere or by a decrease in the absorption to which its light is subject. The aspect of the spectrum does not change materially for a time. A little later there appears the first of a sequence of bright lines which runs throughout the remainder of the cycle while the photospheric spectrum is increasing to a maximum intensity and then fading. These two effects from a common cause apparently proceed with but little interaction. The intensities of the bright lines mark the phase unmistakably but they seem not to bear a simple relationship to the apparent brightness of the photosphere. On the descending branch of the light curve, for example, the intensities of several bright lines differ decidedly from those at the same magnitude on the *ascending* branch. Among the bright lines to develop after maximum, one or two, particularly Mg I λ 4571, persist for a time *after minimum*, thus overlapping the new cycle, indicating that the series of events started by some occurrence near minimum may last longer than a whole period. A similar phenomenon is furnished by the behavior of sun-spots: a given series of spots may remain visible for two or three years after the next cycle begins. This is another instance of periodic disturbances each having a chain of consequences longer than the period.

Carnegie Institution of Washington,
Mount Wilson Observatory, December, 1934.

[19] Ein Beitrag zur Theorie der Mira-Veränderlichen, *A. N.*, **228**, 105, 1926.

[20] Die Langperiodische Veränderlichen, *Veröffentlichungen der Universitäts Sternwarte zu Berlin-Babelsberg*, **9**, 1, 1932.

Planet Notes for May, 1935

By CLIFFORD E. SMITH

The *Sun* will be moving with a northeasterly motion from the central part of Aries to the central part of Taurus. Its distance from the earth will increase, during this period, from about 93.6 million miles to about 94.2 million miles. The position of the sun on the first and last days of the month will be, respectively: R.A. $2^h\ 29^m$, Decl. $+14°\ 43'$; and R.A. $4^h\ 28^m$, Decl. $+21°\ 45'$.

The phenomena of the *Moon* will occur as follows:

New Moon	May	2 at	4 P.M.
First Quarter		10 "	6 A.M.
Full Moon		18 "	4 A.M.
Last Quarter		25 "	4 A.M.
Apogee		11 "	8 A.M.
Perigee		25 "	10 A.M.

Mercury will be moving with an apparent northeasterly motion from central Aries, across Taurus, to western Gemini. At the beginning of the month it will be near the sun in apparent position, but, by the end of the month, it will set about an hour and a half after the sun. Greatest elongation east will occur on May 26 at 4:00 P.M. (22° 51′). Conjunction with the moon will occur only about 15 hours after the occurrence of new moon. At the end of the month, the distance from Mercury to the earth will be about 70 million miles, and its apparent diameter will be about 9 seconds of arc. Its position on the last day of the month will be R.A. $6^h\ 4^m$, Decl. $+24°\ 51'$.

Venus will be moving with an apparent easterly motion from the eastern part of Taurus to the eastern part of Gemini. During this period it will set about three hours after the sun. Its distance from the earth will decrease from about 110 to about 90 million miles. The corresponding change in apparent diameter will be from about 14.4 to about 17.8 seconds of arc. Conjunction with the moon will occur on May 5 at 5:00 P.M. (Venus 38′ S).

Mars will continue as a striking evening object in western Virgo. During the middle of the month it will be toward the south at about 9:00 P.M. local time, and, at this time, its distance from the earth will be about 67 million miles and its apparent diameter will be about 13 seconds of arc. Its apparent motion will be westerly until May 19, when it will become easterly again. Conjunction with the moon will occur on May 14 at 10:00 A.M. (Mars 6°.5 N).

Jupiter will be moving with a small apparent westerly motion in central Libra. During this period it will be above the horizon most of the night hours since opposition with respect to the sun will occur on May 9 at 7:00 P.M. Its distance from the earth will be about 410 million miles and its apparent diameter will be about 42 seconds of arc. Jupiter will be in conjunction with the moon on May 17 at 2:00 P.M. (Jupiter 6°.1 N).

Saturn will be moving with a slow apparent easterly motion in Aquarius. During the middle of the month it will rise soon after midnight. Its distance from the earth will be about 860 million miles, and its apparent diameter will be about 15 seconds of arc. Conjunction with the moon will occur on May 25 at 6:00 P.M. (Saturn 5°.9 S).

Uranus will be too near the sun in apparent position, during this month, to be of interest, since conjunction with the sun will have occurred late in April.

Neptune will be in Leo about 2 degrees west of χ Leonis. Its apparent motion in the sky will be westerly until May 24 when it will become easterly again. During the middle of the month it will be toward the south at about sunset (meridian passage about $7^h\ 30^m$ P.M.). Its distance from the earth will be about 2700 million miles, and its apparent diameter will be about 2½ seconds of arc. It will be in conjunction with the moon on May 12 at 8:00 A.M. (Neptune 5°2 N). Its position on May 14 will be R.A. $10^h\ 54^m$, Decl. +8° 2′.

OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris.*)

Date 1935		Star	Mag.	IMMERSION Greenwich C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Greenwich C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′.											
May	5	Venus	−3.5	23 58.5	−0.1	−2.3	127	0 59.1	−0.4	−1.2	256
	8	149 B.Gem	6.4	1 42.5	..	..	182	2 4.5	..	..	223
	8	63 Gem	5.3	2 11.7	..	..	184	2 29.7	..	..	219
	11	83 B.Leo	5.9	5 18.4	−2.0	−0.9	66	5 55.7	+0.4	−2.4	346
	12	p^6 Leo	5.4	22 13.8	−8.0	−1.3	151	23 28.2	−2.0	+0.2	281
	19	α Sco	1.2	8 16.9	−1.6	−1.8	126	9 14.2	−0.5	−0.4	232
	23	12 Cap	6.1	8 35.8	..	..	355	9 5.0	..	..	313
	25	ρ Aqr	5.4	8 57.0	−1.8	+1.1	84	10 2.8	−1.0	+1.8	208
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′.											
May	6	Venus	−3.5	0 11.2	..	..	173	0 36.2	..	..	211
	11	83 B.Leo	5.9	5 12.0	−0.7	−1.3	87	6 6.8	+0.1	−2.3	332
	11	89 B.Leo	6.3	6 46.5	+0.4	−3.0	177	7 14.1	+0.1	−0.4	236
	15	75 Vir	5.6	23 51.0	−1.5	+2.9	68	0 30.1	+0.4	−2.2	355
	18	153 B.Lib	6.3	9 8.7	−1.3	−1.4	108	10 17.6	−0.6	−1.2	264
	19	α Sco	1.2	7 45.5	−2.0	−1.0	119	8 58.2	−1.5	−0.4	247
	19	116 B.Sco	6.2	9 6.2	−2.2	−2.5	145	9 49.2	−0.4	+0.6	214
	25	ρ Aqr	5.4	8 29.3	−1.0	+1.7	72	9 37.5	−1.1	+1.7	228
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′.											
May	11	83 B.Leo	5.9	4 48.4	−1.1	−2.1	135	6 5.3	−1.0	−2.0	297
	18	153 B.Lib	6.3	8 19.6	−2.2	−0.7	111	9 45.4	−2.0	−0.9	275
	19	α Sco	1.2	6 58.8	−0.9	−1.1	149	7 56.1	−2.7	+1.4	237
	19	116 B.Sco	6.2	8 13.8	..	..	153	9 4.2	..	..	225
	23	υ Cap	5.3	12 59.6	..	..	139	13 11.9	..	..	158
	25	170 B.Aqr	6.1	10 7.8	−0.7	+2.3	30	11 7.0	−1.4	+1.0	273

Variable Stars

Monthly Report of the American Association of Variable Star Observers for February, 1935

In spite of the reports of unfavorable weather prevailing in many quarters, the amount of observing accomplished has been considerable. Among new contributors in recent months we welcome Mrs. Rosina Dafter, of far-away New Zealand, Walter Haas, of New Waterford, Ohio, Victor H. Blunck, of Minneapolis, Minnesota, Armando Marchesini, of Bologna, Italy, H. P. Newton, of New Westminster, British Columbia, Canada, D. S. Reed, of Providence, Rhode Island,

Variable Star Observations Received During February, 1935.

Dec. 0 = J.D. 2427772; Jan. 0 = J.D. 2427803; Feb. 0 = J.D. 2427834.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
V Scl			**T And**			**Y Cep**			**RV Cas**			**Z Cet**			**RU And**		
000339			001726			003179			004746a			*010102*			013238		
776[	13.3	Bl	840	9.8	Jo	840	9.5	Jo	813	13.9	Ar	840	11.0	Jo	833	12.8	Wu
803[	13.3	Bl	845	10.0	Jo	841	9.5	Ie	814	13.9	Ar	**U Scl**			847	12.8	Bs
S Scl			**T Cas**			845	9.7	Jo	826	14.4	Ar	*010630*			**Y And**		
001032			001755			**U Cas**			829	14.4	Ar	776	10.3	Bl	013338		
776	7.7	Bl	804	10.8	Pb	004047a			832	13.7	B	784	10.5	Bl	820	11.1	Hf
784	8.1	Bl	813	11.3	Pb	758	9.1	Kn	—		Cas	792	10.8	Bl	827	9.9	Pt
792	8.2	Bl	813	11.4	Hk	802	11.3	Kn	004746b			803	10.9	Bl	832	9.8	B
799	9.1	Ht	814	11.1	Hf	804	11.2	Pf	804	10.6	Pf	**U And**			837	9.2	Jo
802	8.5	dK	820	10.8	B	804	10.1	Pb	807	10.9	Ar	010940			840	9.4	Jo
803	9.0	Bl	827	11.4	Pt	805	11.1	Hu	813	10.9	Ar	786	10.8	Fc	840	9.6	Md
803	9.2	Ht	828	11.0	Wh	809	11.2	Hi	814	10.8	Ar	809	12.2	Be	840	9.9	Hf
809	8.9	dK	830	11.6	Wd	813	11.6	B	826	11.1	Ar	820	12.1	B	845	9.6	Jo
810	9.5	Ht	831	11.5	Ra	813	11.8	Hk	827	11.5	Pt	829	12.2	Bs	**X Cas**		
815	9.5	Ht	834	12.0	Jo	814	11.8	Hf	829	11.1	Ar	847	12.8	Bs	014958		
816	9.2	dK	837	11.9	Jo	819	12.2	Bs	**W Cas**			**UZ And**			804	11.7	Pb
822	9.6	Kd	840	11.8	Jo	824	12.4	Hi	004958			011041			810	11.4	Wu
823	9.6	Kd	840	11.2	Hf	826	12.0	Hu	804	12.0	Pb	786[	12.9	Fc	813	11.5	Hk
823	9.2	dK	845	12.0	Jo	833	12.0	Wh	813	12.0	Pb	807	14.5	Ar	827	11.6	Pt
X And			**R And**			834	12.9	Hi	813	12.0	Hk	808	14.5	Pb	829	11.4	Bs
001046			001838			840	13.4	Bs	815	11.6	Hf	813	15.2	Ar	833	10.9	Wu
786[	12.9	Fc	786[	12.9	Fc	**RW And**			820	11.2	B	826	14.8	Ar	834	11.4	Jo
804	12.5	Pf	809	14.0	Be	004132			827	12.0	Pt	**S Psc**			836	10.5	Md
805	12.7	Es	829	14.6	Mg	786[	12.5	Fc	829	11.7	Bs	011208			837	11.0	Jo
827	10.4	Jo	840[	13.9	Bs	809	14.3	Be	831	11.2	Ra	782	10.6	Fc	840	10.3	B
832	10.1	B	**S Tuc**			827[	12.6	Pt	834	11.2	Jo	828	12.2	Bj	847	11.2	Bs
834	9.8	Jo	*001862*			834[	13.1	Ie	836	11.3	My	842	12.4	Bj	**U Per**		
837	10.0	Jo	776	12.6	Bl	**RX Cep**			837	11.2	Jo	**S Cas**			015254		
840	9.8	Jo	782	12.9	Sl	004281			838	11.0	Wd	011272			802	10.4	Kn
845	9.4	Jo	798	13.2	Ht	811	7.3	Lt	840	11.1	Bs	813[	12.3	Pb	807	10.6	Fr
T Cet			803[	13.5	Bl	**V And**			840	11.0	Jo	827[	13.0	Pt	810	10.1	Ry
001620			811[	13.1	Ht	004435			840	11.3	Hf	832	12.8	B	813	9.9	Ry
811	6.6	Lt	**S Cet**			786	9.3	Fc	845	11.4	Jo	834	13.0	Wu	820	10.4	Hf
816	6.6	Lt	*001909*			805	9.1	Es	**U Tuc**			838	12.8	Ie	821	9.9	Ry
821	6.4	Kd	809	11.2	Hi	809	8.8	Be	*005475*			**U Psc**			827	10.0	Jo
822	6.4	Kd	823	10.5	Hi	813	9.4	Pb	776	9.2	Bl	011712			830	9.3	Ry
824	6.4	Kd	827	10.8	Pt	814	9.2	Sz	782	9.2	Sl	782	12.1	Fc	832	9.3	B
825	6.3	Lt	830	10.3	Hf	820	9.1	B	784	9.8	Bl	827	11.7	Pt	834	9.7	Jo
833	6.0	Lt	834	10.1	Hi	826	9.7	Fr	792	9.9	Bl	840	12.0	Jo	834	9.1	Cy
838	6.1	Kd	840	10.1	Hf	830	9.0	Jo	798	9.9	Ht	**R Scl**			836	9.4	My
T And			**T Phe**			834	9.2	Jo	803	10.3	Bl	*012233a*			837	9.5	Jo
001726			*002546*			837	9.4	Jo	803	10.3	Ht	822	7.8	Kd	838	8.5	Ba
786	8.4	Fc	776	13.5	Bl	840	9.7	Jo	811	11.0	Ht	823	7.8	Kd	840	9.4	Hf
805	8.3	Es	792	12.5	Bl	845	10.0	Jo	**Z Cet**			**RZ Per**			841	8.6	Ba
809	8.6	Hi	798	12.2	Ht	**X Scl**			*010102*			012350			846	8.8	Wd
814	9.0	Hf	803	10.6	Ht	*004435*			782	9.2	Fc	821	11.0	B	**XX Per**		
820	8.9	B	803	11.2	Bl	776	11.5	Bl	805	8.9	Es	840	11.8	Md	015654		
824	9.0	Hi	810	10.2	Ht	784	11.7	Bl	807	8.9	Fr	**R Psc**			811	8.4	Lt
826	9.9	Fr	815	10.1	Ht	792	11.3	Bl	809	9.0	Hi	012502			825	8.4	Lt
827	9.3	Jo	**W Scl**			803	11.3	Bl	813	9.0	Pb	782	12.3	Fc	**S Ari**		
827	9.0	Pt	*002833*			**RR And**			814	9.4	Hf	809	13.1	Be	015912		
830	10.4	Po	776	13.0	Bl	004533			824	9.9	Hi	827[	12.0	Pt	813[	14.3	Pb
830	9.4	Hf	803	13.0	Bl	786[	12.6	Fc	827	9.8	Pt	**RU And**			835[	13.7	B
834	9.5	Hi	**Y Cep**			809[	13.9	Be	830	10.4	Hf	013238			**R Ari**		
834	9.4	Jo	003179			**RV Cas**			830	10.0	Jo	804	11.4	Pb	021024		
836	9.5	Md	830	9.2	Jo	004746a			834	10.4	Jo	827	12.2	Pt	786	11.1	Fc
837	9.7	Jo	834	9.2	Jo	804	13.0	Pf	834	11.0	Hi	829	12.8	Bs	814	9.2	Hf
840	9.6	Hf	837	9.3	Jo	807	13.3	Ar	837	10.7	Jo	832	12.8	B	822	8.3	Ah

Variable Star Observations Received During February, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R Ari			o Cet			o Cet			o Cet			o Cet			S Per		
021024			*021403*			*021403*			*021403*			*021403*			021558		
827	8.7	Pt	786	2.8	SL	814	2.8	Fr	827	3.2	Mc	835	3.8	Hm	827	9.6	Dl
829	7.9	Ah	786	3.8	Ah	814	3.1	Hu	827	3.5	Ra	835	3.3	Mh	827	8.8	Pt
830	8.1	Hf	787	3.0	Df	814	2.7	Dh	827	3.3	Rb	836	3.8	Hm	828	9.3	Hl
832	8.4	B	788	3.0	SL	814	2.8	Af	827	3.5	Dl	836	3.3	Mh	829	9.3	Fr
834	8.4	Jo	795	2.5	Df	814	2.5	Ra	827	2.9	Hm	837	3.4	Mh	830	9.6	Cm
837	8.3	Jo	800	2.5	Df	814	2.3	Rb	827	3.5	Pt	837	3.5	Kd	830	9.4	Wd
840	7.8	Jo	801	2.0	Ah	814	3.0	Hf	827	3.4	Hf	837	3.9	Hm	830	9.6	Dl
840	8.1	Hf	802	2.5	Df	814	2.9	Mh	827	3.3	Sf	837	3.3	Jo	833	9.4	Cl
842	8.0	Wh	804	2.5	Dh	814	2.7	Pb	827	3.2	Mh	838	3.9	Ba	833	9.0	Si
846	8.0	Wd	804	2.6	Hv	815	3.2	SL	827	3.0	Jo	838	3.8	Rb	833	9.7	Dl
W And			804	2.6	Fn	815	2.4	Rb	827	3.4	Kd	838	3.8	Wd	834	9.3	Sq
021143a			804	2.6	Si	816	3.2	Hu	828	3.2	Hh	838	3.7	Dl	834	9.2	Cy
827	11.5	Pt	804	2.6	By	816	3.1	Si	828	3.4	SL	838	3.8	Hm	834	9.7	Dl
828	11.0	Bj	804	2.5	Pb	816	2.9	Mh	828	3.3	Dh	838	3.8	Hb	834	8.9	Jo
830	11.4	Hf	805	2.6	Pb	817	2.9	Mh	828	3.5	Hm	838	3.4	Mh	835	9.7	Dl
835	11.3	B	805	3.1	SL	817	2.9	Hv	828	3.0	Kg	839	3.5	Mh	836	9.0	My
840	11.5	Hf	805	2.4	Hu	817	2.5	Rb	829	2.8	Fr	839	3.6	Kd	837	8.9	Jo
842	11.9	Bj	805	2.5	Dh	818	3.0	Ah	829	3.3	Dh	840	3.9	Rb	838	9.2	Cy
T Per			805	2.6	Hv	818	3.0	Dh	829	3.4	Hv	840	4.0	Hm	838	9.7	Dl
021258			805	2.8	Bc	818	2.9	Hm	829	2.9	Pb	840	4.0	Dl	840	9.2	B
805	9.4	Cl	805	2.7	Fn	818	2.9	Mh	830	3.6	Ba	840	4.0	Hf	840	9.2	Md
811	9.1	Lt	806	2.4	Fr	819	2.9	Mh	830	3.5	Fn	840	3.5	Jo	840	9.7	Dl
817	9.0	Dl	806	2.5	Hu	819	2.9	Hm	830	3.7	Rb	840	4.0	Sf	840	9.3	Hf
820	9.0	Hf	806	2.5	Dh	819	3.3	L	830	3.5	Si	841	4.0	Rb	840	9.0	Jo
826	9.1	Ra	806	2.6	Hv	819	3.0	Hv	830	3.7	Wd	841	4.0	Dl	841	9.7	Dl
827	9.1	Dl	806	2.7	Bc	819	2.8	Ra	830	3.6	Dl	841	4.1	Hm	845	9.1	Jo
827	8.8	Pt	806	2.7	Fn	820	3.0	Hu	830	3.5	Hm	844	3.6	Mh	845	9.7	Dl
828	9.0	Hl	806	2.8	Si	820	3.1	Ba	830	2.9	Pb	845	4.2	Hm	846	9.7	Dl
830	9.2	Wd	806	2.8	By	820	2.9	Mh	831	3.3	Mc	845	4.1	Dl	R Cet		
830	9.2	Dl	806	2.5	Pb	820	2.9	Pb	831	3.6	Si	845	3.7	Jo	*022000*		
830	8.9	Hf	807	2.4	Ar	821	2.8	Ra	831	3.6	Hm	846	4.1	Dl	807	10.3	Fr
833	9.0	Cl	807	2.5	Fr	821	3.2	Rb	831	3.4	Bu	847	4.2	Hm	809	10.1	Be
833	9.2	Si	807	3.1	SL	821	3.0	Dl	832	3.6	Hb	SU Per			809	10.2	Hi
833	9.2	Dl	807	2.8	Hu	821	2.8	Hm	832	3.7	Rb	021556b			814	9.6	Hf
834	9.3	Dl	807	2.7	Hv	821	2.7	Kg	832	3.7	Hm	724	8.0	Lt	823	8.1	Hi
834	8.5	Jo	807	3.0	Si	821	3.0	Mh	832	3.2	Kg	739	8.1	Lt	824	7.9	Hi
834	9.0	Sq	808	2.5	Hu	821	3.3	Kd	833	3.7	Fn	757	8.1	Lt	830	7.9	Dl
837	8.6	Jo	808	2.5	Dh	822	3.3	Ah	833	3.7	Rb	768	8.2	Lt	830	7.8	Hf
838	9.4	Dl	808	2.6	Af	822	3.3	Kd	833	3.7	Si	795	8.0	Lt	833	7.9	Dl
840	8.5	Jo	808	2.7	Fn	823	3.3	Kd	833	3.7	Wa	827	7.9	Lt	835	7.9	Dl
845	8.6	Jo	808	2.7	Sd	823	3.4	Ah	833	3.9	Wd	837	8.1	Lt	835	7.8	Hm
Z Cep			808	2.7	Pb	823	3.0	Hb	833	3.6	Dl	838	8.1	Lt	837	7.8	Jo
021281			809	2.8	Pb	824	3.2	Hu	833	3.8	Hm	S Per			838	7.8	Dl
827	[12.5	Pt	809	2.6	Dh	824	3.1	Dh	833	3.2	Mh	021558			838	7.8	Wd
840	[14.0	Ie	809	2.7	Hu	824	3.2	Hv	833	3.4	Kd	805	9.2	Cl	838	8.0	Hm
o Cet			809	2.9	Hv	824	3.4	Kd	834	3.5	Mc	807	9.3	Fr	839	7.7	Kd
021403			809	3.1	Be	825	3.4	SL	834	4.0	Ra	808	9.7	Af	840	7.7	Jo
739	8.0	Df	810	2.7	Mg	825	3.2	Dh	834	3.8	Rb	809	9.6	Dh	840	7.8	Hf
744	7.0	Df	811	2.7	Mh	825	3.3	Si	834	3.8	Wa	813	9.3	Fr	840	7.9	Dl
766	5.0	Df	812	3.0	Hu	825	2.8	Pb	834	4.1	Cy	813	9.4	Af	840	7.9	Hm
770	4.5	Df	812	2.8	Mh	826	2.8	Fr	834	3.7	Dl	814	9.8	Fr	845	8.0	Hm
775	4.2	Df	813	3.2	SL	826	3.4	Hu	834	3.7	Hm	814	9.4	Dh	845	7.7	Jo
778	3.9	Df	813	2.6	Af	826	3.2	Dh	834	3.0	Jo	814	9.8	Af	846	8.2	Dl
781	3.4	Df	813	3.0	Hu	826	3.2	Hv	834	3.3	Mh	814	9.1	Sz	RR Per		
782	3.6	SL	813	2.7	Dh	826	3.4	Bu	835	3.5	Mc	817	9.3	Dl	022150		
783	3.6	SL	813	2.9	Hv	826	2.9	Pb	835	3.4	Bu	820	9.3	Hf	807	10.0	Hk
783	3.3	Df	813	2.9	Pb	826	3.1	Mh	835	3.8	Rb	826	9.3	Fr	808	10.1	Wu
784	3.5	SL	813	2.8	Mh	827	3.2	Dh	835	4.1	Dl	826	9.5	Ra	815	9.8	Wu

Variable Star Observations Received During February, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RR Per			R Tri			W Per			Y Per			R Tau			S Tau		
022150			023133			024356			032043			042209			042309		
820	10.0	Hf	830	6.8	Hf	834	9.1	Jo	781	8.9	Ah	779	11.8	Fc	779[	13.0	Fc
827	10.0	Pt	833	6.7	Ra	834	9.4	Dl	805	8.7	Hv	805	10.0	Hu	807	13.8	Ar
830	10.0	Hf	833	6.8	Si	835	9.4	Dl	805	8.7	Bc	805	9.5	Hk	813	14.1	Ar
833	10.4	Ra	834	6.3	Jo	835	9.7	Mc	806	8.6	Hv	807	9.6	Ar	826	14.2	Ar
734	10.3	Cm	835	6.9	Wd	836	9.0	My	813	8.6	Pb	809	9.2	Hi	838[	13.5	Ie
840	10.2	B	837	6.0	Jo	837	9.8	Mc	814	8.2	Fr	813	8.9	Ar	847[	13.0	Bs
RS Cet			838	5.5	Dl	837	9.0	Jo	814	8.2	Dh	813	8.9	Pb	T Cam		
022200			840	5.4	Dl	838	9.4	Dl	814	8.3	Af	824	8.9	Hi	043065		
807	7.9	Fr	840	6.4	Hf	839	9.2	Hb	820	8.8	Hf	826	9.0	Ar	817	10.4	Dl
833	8.5	Lt	840	5.8	Jo	840	8.9	B	822	8.7	Ah	826	8.9	Hk	829	10.7	Fr
838	8.3	Wd	841	6.6	Pv	840	9.3	Dl	826	8.4	Fr	826	9.0	Hu	829	10.3	Pt
838	8.6	Lt	846	5.5	Dl	840	9.0	Jo	827	8.0	Pt	829	9.4	Bs	830	10.7	Dl
R For			T Ari			841	8.9	Pv	829	8.9	Bs	829	8.6	Pt	833	10.7	Dl
022426			024217			841	9.4	Dl	830	9.0	Hf	830	9.1	Hf	840	11.7	Hf
784[	12.9	Bl	786	8.4	Fc	845	9.3	Dl	831	9.0	Ra	832	8.7	Ie	RX Tau		
803	12.0	Bl	805	9.5	Hu	845	9.4	Wd	833	8.5	Wh	834	9.1	Hi	043208		
827	12.0	Jo	814	9.4	Af	846	9.3	Dl	834	8.2	Sq	834	8.6	Cy	779	12.0	Fc
830	12.2	Bj	814	9.5	Fr	RR Eri			834	8.5	Jo	837	8.7	Jo	799	11.6	Fc
841	12.1	Bj	826	9.1	Hu	*024708*			837	8.4	Jo	840	9.0	Md	813	11.4	Fr
841	12.0	Jo	829	9.6	Fr	807	7.7	Fr	837	8.8	Mc	840	9.3	Cm	829	10.4	Hk
U Cet			829	8.8	Bs	R Hor			840	8.5	Jo	845	9.0	Wd	829	10.6	Pt
022813			829	9.6	Pb	*025050*			845	9.0	Bs	847	9.5	Bs	830	10.7	Rb
782	12.6	Fc	834	8.6	Jo	776	8.8	Bl	845	9.0	Wd	W Tau			841	10.6	Rb
807	10.8	Fr	837	8.7	Jo	784	9.6	Bl	R Per			042215			R Ret		
807	9.7	Fn	840	9.0	Hf	784	8.9	Sl	032335			779	10.8	Fc	*043263*		
807	10.8	Si	841	8.7	Jo	792	10.0	Bl	809	13.5	Wu	804	10.7	Dh	776	7.5	Bl
814	10.0	Hf	845	8.8	Jo	798	10.2	Ht	829	13.4	Bs	804	10.6	Pb	784	8.2	Bl
815	9.8	Hf	845	8.9	Bs	802	10.6	dK	834	12.9	Ie	805	10.9	Pb	784	7.6	Sl
820	9.6	Hf	Z Eri			803	11.0	Ht	835	13.0	B	805	11.0	Hk	798	9.4	Ht
826	8.7	Hb	*024312*			803	10.4	Bl	836	12.8	My	805	11.1	Hu	803	9.4	Ht
828	8.6	Hh	807	6.5	Fr	809	10.7	dK	840	12.6	Md	806	10.6	Dh	803	8.9	Bl
828	8.8	Bj	W Per			811	11.2	Ht	847	12.5	Bs	807	10.7	Fr	811	9.8	Ht
828	9.0	Hf	024356			816	11.0	dK	Nov Per			808	10.6	Af	818	10.1	Ht
830	8.9	Hf	805	9.4	Hv	818	11.2	Ht	032443			809	10.6	Dh	X Cam		
830	8.8	Jo	805	9.4	Bc	823	11.6	dK	806	13.3	Ar	813	11.1	Pb	*043274*		
832	8.7	Cm	806	9.4	Hv	T Hor			807	13.3	Ar	814	10.8	Dh	779[	12.8	Fc
833	8.5	Lt	807	10.3	Fr	*025751*			813	13.8	Ar	814	10.6	Af	808	10.9	Kn
837	8.3	Lt	808	10.2	Af	776	11.8	Bl	814	13.8	Ar	814	10.6	Fr	811	10.4	B
837	8.1	Jo	809	10.2	Dh	784	11.0	Bl	826	13.7	Ar	815	11.0	Hu	829	10.0	Pt
838	8.5	Hb	810	9.4	Rb	784	11.4	Sl	827	13.1	Pt	818	10.8	Md	834	10.0	Cy
840	8.6	Hf	813	9.6	Rb	79?	10.7	Bl	829	12.9	Ar	826	11.4	Fr	836	9.8	My
840	7.7	Jo	814	10.3	Fr	798	10.7	Ht	U Cam			826	11.3	Hu	840	10.0	Hf
841	8.5	Bj	814	10.3	Dh	803	9.9	Ht	033362			829	11.3	Ar	840	9.9	Md
845	7.6	Jo	814	10.3	Af	803	9.9	Bl	833	7.6	Si	829	11.3	Fr	846	9.8	Wd
RR Cep			821	9.2	Rb	811	9.8	Ht	834	8.1	Cy	829	11.3	Hk	R Dor		
022980			823	9.0	Hb	818	9.8	Ht	838	8.1	Cv	829	10.7	Dh	*043562*		
827[	12.5	Pt	826	9.4	Ra	X Cet			840	8.2	Hf	829	10.7	Bs	776	5.5	Bl
840	11.8	Ie	826	10.0	Fr	*031401*			X Per			829	10.9	Pt	776	5.7	Sl
R Tri			827	9.3	Pt	782	9.8	Fc	034930			829	10.9	Pb	784	5.7	Sl
023133			828	9.0	Hl	786	10.2	Fc	825	6.3	Lt	830	11.6	Ba	784	6.1	Bl
813	8.1	Fr	829	9.9	Fr	826	11.5	Hu	837	6.4	Lt	830	11.7	Rb	798	5.8	Ht
813	8.1	Af	829	9.6	Pb	827	12.1	Pt	837	6.5	Mc	830	11.0	Hf	803	5.8	Ht
820	7.9	Hf	830	9.2	Rb	828	12.3	Bj	844	6.5	Lt	834	11.2	Cy	803	6.0	Bl
822	7.2	Ah	830	9.6	Hf	830	12.4	Po	T Eri			836	10.9	My	811	5.8	Ht
826	7.5	Hu	832	9.1	Hb	830	12.0	Ba	*035124*			837	10.4	Jo	818	5.7	Ht
827	6.7	Pt	833	9.2	Wh	841	12.3	Bj	828	13.2	Bj	838	10.9	Ba	R Cae		
828	8.0	Bj	834	9.1	Hl				841	13.3	Bj	845	11.2	Wd	*043738*		
829	7.0	Ah	834	9.4	Cy							845	11.0	Bs	776	8.3	Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R CAE			R LEP			R LEP			R AUR			W AUR			S ORI		
043738			*045514*			*045514*			050953			052036			*052404*		
784	7.9	Bl	804	7.1	Si	845	9.4	Dl	845	13.0	Wd	808	9.5	Si	832	9.9	Dl
792	7.4	Bl	804	7.1	By	845	9.3	Hm	T PIC			808	9.5	Sd	833	10.1	Dl
798	8.2	Ht	804	8.3	Pb	845	7.7	Jo	*051247*			809	9.5	Hi	834	10.1	Dl
803	7.7	Ht	805	8.5	Ar	846	9.3	Dl	776	11.4	Bl	813	9.5	Fr	834	9.6	Jo
803	8.3	Bl	805	8.4	Hk	V ORI			784	10.5	Bl	813	9.4	Af	837	9.6	Jo
811	8.1	Ht	806	8.4	Pb	050003			798	10.2	Ht	816	9.3	Fn	838	10.2	Dl
R PIC			807	7.8	Hh	779	12.8	Fc	803	9.2	Bl	823	10.0	Hi	840	9.9	Hf
044349			807	7.2	Si	782	12.4	Fc	803	9.3	Ht	826	9.8	Fr	840	10.2	Dl
776	8.1	Bl	808	7.7	Sd	799	11.3	Fc	811	8.7	Ht	829	10.7	Pt	840	9.7	Jo
784	8.1	Bl	808	8.5	Pb	814	10.9	Hf	NOV TAU			833	10.2	Fn	841	9.9	Rb
798	8.7	Ht	809	8.5	Pb	827	10.4	Jo	051316			840	10.5	Hf	845	10.1	Dl
803	8.1	Ht	813	8.7	Pb	827	10.6	Hf	806	14.9	Ar	840	10.7	Ie	846	10.2	Dl
803	7.8	Bl	813	8.9	Fr	829	10.2	Pt	807	14.5	Ar	846	10.5	Wd	T ORI		
811	7.7	Ht	813	8.5	Kp	830	10.7	Cl	813	14.1	Ar	846	11.1	Cm	*053005a*		
V TAU			813	8.8	Af	834	9.7	Jo	814	13.9	Ar	S ORI			804	9.6	Dh
044617			814	8.8	Fr	840	10.4	B	826	14.1	Ar	*052404*			804	9.6	Lf
779	11.1	Fc	814	8.9	Dh	840	10.4	Hf	829	14.5	Ar	779	9.5	Fc	804	10.2	Pb
799	9.0	Fc	814	8.8	Af	840	10.4	Ie	T COL			785	9.4	Fc	805	10.1	Hk
805	9.3	Hk	814	8.8	Hf	840	10.6	Md	*051533*			799	8.9	Fc	805	10.1	Hu
813	9.3	Fr	814	9.0	Pb	841	9.0	Jo	776	9.4	Bl	803	9.4	Fc	805	10.1	Pb
813	9.3	Af	821	8.4	Hm	845	8.7	Jo	784	10.0	Bl	804	9.9	Dh	806	10.5	Ar
813	9.3	Pb	821	8.6	Dl	845	9.9	Wd	798	10.8	Ht	804	9.7	Pb	806	10.6	Dh
829	9.6	Hk	825	9.2	Pb	846	10.2	Cm	802	11.2	dK	805	9.9	Hk	806	10.6	Fr
829	9.8	Bs	826	9.3	Pb	T LEP			803	11.5	Ht	805	9.6	Hu	806	10.6	Pb
840	9.8	Ie	826	9.2	Fr	*050022*			803	11.6	Bl	806	9.9	Fr	807	10.5	Hk
847	10.4	Bs	827	8.3	Hm	776	11.2	Bl	811	11.9	Ht	806	9.8	Dh	807	10.2	Ar
AB AUR			827	9.0	Dl	784	11.0	Bl	823	11.9	Kd	806	9.7	Pb	807	10.6	Fr
044930			827	7.7	Jo	799	10.1	Fc	824	11.9	Kd	807	8.8	Fn	808	10.0	Af
817	6.9	Lt	828	8.1	Hh	803	9.9	Bl	826	11.9	Kd	807	9.9	Fr	808	10.2	Pb
825	6.9	Lt	828	8.5	Hm	807	9.4	Fr	829	11.9	Kd	808	9.9	Af	809	10.0	Dh
837	7.0	Lt	829	7.4	Pt	814	9.0	Hf	839	12.0	Kd	808	9.6	Pb	809	10.1	Pb
R ORI			829	9.2	Pb	817	8.8	B	S AUR			809	9.9	Dh	813	10.0	Hk
045307			830	8.9	Kp	827	8.6	Jo	052034			812	8.9	B	813	9.8	Af
779	10.4	Fc	830	8.9	Hf	828	9.3	Hl	805	10.3	Hu	813	9.7	Hk	813	9.6	Ar
782	10.4	Fc	830	7.7	Hb	828	8.7	Bj	813	10.5	Fr	813	9.8	Pb	813	10.0	Pb
799	9.2	Fc	830	7.5	Si	829	9.0	Pt	813	10.4	Af	814	9.6	Fr	814	9.6	Af
805	9.9	Hk	830	8.9	Wd	829	9.4	Pb	817	9.3	B	814	9.8	Dh	814	10.0	Hf
805	9.3	Hu	830	9.0	Dl	830	8.6	Hf	817	10.4	Dl	814	8.9	Sz	814	10.1	Dh
812	9.0	B	830	8.7	Hm	830	8.7	Wd	826	10.3	Fr	814	9.3	Hf	814	9.6	Fr
813	9.5	Hk	832	7.7	Hb	833	8.4	Wh	827	9.2	Mc	815	9.6	Hf	814	9.9	Pb
813	9.6	Pb	832	9.0	Dl	834	8.0	Jo	827	10.5	Dl	816	9.6	Fn	815	10.1	Hu
814	9.4	Fr	833	7.7	Si	837	8.2	Jo	829	10.3	Fr	817	9.3	Rb	815	10.0	Hf
814	9.4	Af	833	9.2	Dl	840	8.0	Jo	829	9.0	Pt	817	9.1	Sh	817	9.9	Sh
829	9.9	Hk	834	7.6	Jo	840	8.5	Hf	829	10.3	Pb	826	9.9	Fr	820	10.3	Wa
838	9.9	Cy	834	9.1	Dl	841	8.7	Bj	830	10.4	Dl	826	9.8	Hu	821	10.2	B
846	9.9	Cm	835	9.1	Hm	845	7.8	Jo	830	10.9	Ba	826	9.5	Ra	824	10.2	Wa
R LEP			835	9.2	Dl	S PIC			833	10.0	Rb	827	9.9	Dl	826	10.2	Pt
045514			837	7.7	Jo	*050848*			834	10.5	Dl	827	9.7	Jo	826	10.1	Hu
721	7.4	Df	838	9.3	Dl	776	11.1	Bl	836	10.4	My	828	9.7	Hf	826	10.2	Ar
739	6.0	Df	838	9.0	Hm	784	11.3	Bl	838	10.3	Ba	829	9.8	Dh	826	9.8	Fr
743	6.0	Df	839	9.3	Ra	798	11.6	Ht	838	10.5	Dl	829	9.9	Fr	826	10.3	Ra
747	6.0	Df	840	9.3	Dl	803	11.7	Bl	840	10.5	Hf	829	9.8	Pt	827	10.2	Pt
766	6.4	Df	840	9.3	Hf	803	11.8	Ht	845	10.3	Wd	830	10.0	Cm	827	10.4	Jo
770	6.4	Df	840	9.1	Hm	811	12.2	Ht	W AUR			830	9.7	Fn	827	10.0	Hf
777	7.0	Sl	841	9.3	Dl	R AUR			052036			830	9.3	Rb	828	10.5	Pt
778	6.9	Df	841	9.2	Hm	050953			805	9.3	Hi	830	9.6	Si	829	10.2	Pt
784	6.7	Sl	841	7.8	Jo	829	13.0	Pt	805	9.5	Hu	830	9.6	Wd	829	10.2	Pb
802	7.5	Df	842	8.6	Hb	840	13.4	Bs	808	9.7	Fn	830	10.1	Dl	829	10.0	Ar

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
T ORI			AN ORI			SU TAU			α ORI			U ORI			TV GEM		
053005a			*053005t*			054319			*054907*			054920a			060521		
829	10.3	Dh	826	11.2	Hu	814	9.9	Ar	776	1.2	Sl	832	6.8	Kg	816	6.6	Lt
829	10.1	Fr	826	11.5	Ra	814	10.0	Hf	784	1.1	Sl	833	6.4	Si	826	6.9	Lt
830	10.1	Hf	829	12.0	Ar	825	9.5	Si	812	1.1	Lt	833	6.6	Bj	838	6.8	Lt
830	10.0	Po	829	11.7	Dh	826	9.9	Ar	825	1.0	Lt	833	6.9	Dl	V AUR		
830	10.1	Cm	829	11.9	Pb	826	9.9	Pt	833	0.4	Si	833	6.8	Hm	061647		
830	10.4	Wd	830	11.3	Rb	827	9.9	Pt	836	1.1	Lt	834	6.6	B	812	10.9	B
830	10.6	Wa	830	11.3	Wp	828	9.7	Pt	U ORI			834	7.1	Dl	V MON		
830	10.9	Wp	830	11.6	Wd	829	10.0	Ar	054920a			835	7.1	Dl	*061702*		
830	10.4	Rb	830	11.4	Wa	829	9.7	Pt	779	5.9	Fc	835	6.9	Bu	779	11.9	Fc
832	10.4	Pt	835	11.5	Wp	830	9.7	Fn	781	6.4	Ah	835	6.6	Hm	803	10.8	Fc
833	10.5	Pt	835	11.4	Wa	830	9.7	Si	785	6.0	Fc	836	7.1	Hm	804	10.8	Si
834	10.5	Cy	836	11.5	Wa	830	9.9	Hf	786	6.6	Ah	837	7.1	Hm	813	10.2	Hk
834	10.5	Jo	838	11.6	Wp	830	9.7	Wd	803	6.2	Fc	838	7.2	Dl	813	10.0	Pb
835	10.7	Pt	840	11.7	Hf	832	9.8	Pt	804	6.4	Kp	838	7.3	Hm	814	10.8	Hf
835	10.7	Wa	846	11.5	Wd	833	9.9	Rb	804	6.1	Si	839	7.3	Kd	829	9.0	Hk
835	10.6	Wp	S CAM			833	9.7	Pt	804	6.2	By	839	7.6	Hb	829	9.0	Pt
836	10.7	Pt	053068			833	9.9	Si	805	6.4	Hk	840	7.2	Hm	830	9.4	Jo
837	10.6	Jo	804	10.3	Pb	833	9.8	Wa	805	7.0	Hu	840	7.1	Dl	830	9.2	Hf
838	10.6	My	808	10.0	Kn	833	9.7	Wp	807	7.1	Hh	840	7.5	Hf	840	8.9	Hf
838	10.6	Pt	829	9.5	Pt	834	9.7	Cy	807	6.3	Fr	840	7.5	Md	841	8.7	Ie
838	10.6	Wa	838	9.5	My	835	9.7	Wp	807	6.0	Fn	841	7.2	Hm	UU AUR		
838	10.5	Wp	840	9.8	Md	836	9.6	Pt	807	6.2	Si	845	7.3	Hm	062938		
838	10.6	Cy	840	9.5	Hf	838	9.9	Wp	808	6.0	Sd	845	7.5	Bs	826	5.6	Lt
840	11.4	Hf	RR TAU			838	9.8	Wa	811	6.0	Je	846	7.3	Hm	835	5.6	Mc
840	11.0	Jo	053326			838	9.6	Pt	813	6.8	Fr	UW ORI			837	5.6	Lt
841	10.4	Rb	803	11.5	Fc	838	9.8	Cy	813	7.0	Hk	054920b			R MON		
843	10.5	Pt	807	11.7	Ar	840	10.1	Hf	813	6.2	Kp	830	11.0	Wd	063308		
845	11.1	Bs	807	11.1	Ry	840	9.9	Ie	814	6.8	Hf	V CAM			779	11.8	Fc
845	11.2	Jo	813	12.0	Ar	842	9.7	Pt	814	6.9	Kd	054974			803	11.8	Fc
846	10.3	Wd	813	11.7	Ry	843	9.6	Pt	816	6.0	Si	838	13.6	Ie	807	12.3	Ar
AN ORI			814	12.0	Ar	846	9.8	Wd	817	6.1	Kg	Z AUR			813	12.6	Ar
053005t			826	12.3	Ar	S COL			821	6.0	Kg	055353			814	11.7	Ar
804	11.6	Pb	828	11.1	Ry	*054331*			822	7.2	Kd	813	10.7	Fr	826	12.4	Ar
804	11.7	Dh	829	11.2	Ar	776	12.9	Bl	822	5.7	Ah	813	10.6	Af	829	12.4	Ar
804	11.5	Lf	830	11.1	Ry	784	12.6	Bl	826	6.5	Fr	827	10.2	Pt	830	10.6	Jo
805	11.6	Hk	831	10.9	Ry	798	12.1	Ht	826	7.5	Hu	832	10.2	Pt	830	12.2	Bj
805	11.7	Hu	833	11.0	Rb	803	11.8	Ht	826	6.6	Bu	833	9.8	Rb	837	10.6	Jo
805	11.7	Pb	834	11.3	Cy	803	11.9	Bl	827	7.0	Mc	834	10.5	Cy	840	11.9	B
806	11.5	Ar	838	11.4	Cy	811	11.8	Ht	827	6.0	Hb	838	10.6	Cy	841	10.7	Jo
806	11.7	Dh	RU AUR			Z TAU			827	6.7	Dl	840	10.3	Bs	NOV PIC		
806	11.6	Pb	053337			054615a			827	6.7	Hm	841	10.5	Jo	*063462*		
807	11.7	Hk	807	14.3	Ar	805	12.9	Hk	828	7.8	Ht	845	10.5	Jo	798	9.1	Ht
807	11.8	Ar	829	[12.0	Pt	840	13.7	Ie	828	6.6	Hm	R OCT			803	9.1	Ht
808	11.7	Pb	U AUR			RS TAU			828	6.3	Kg	*055686*			811	9.1	Ht
809	11.7	Dh	053531			054615b			828	7.1	Kd	776	8.8	Bl	818	8.7	Ht
809	11.5	Pb	812	13.1	B	805	9.3	Hk	829	6.8	Sq	784	7.5	Bl	S LYN		
813	11.7	Hk	829	13.2	Pt	840	9.0	Ie	829	6.2	Pt	798	6.8	Ht	063558		
813	11.5	Af	838	13.7	Ie	RU TAU			829	6.8	Ah	803	7.1	Ht	813	11.7	Hk
813	11.7	Ar	SU TAU			054615c			829	6.5	Hk	803	7.2	Bl	813	11.4	Ry
813	11.5	Pb	054319			805	12.7	Hk	830	6.8	Kp	811	8.1	Ht	831	12.4	Ry
814	11.5	Dh	785	10.4	Fc	813	14.0	Ar	830	7.1	Cl	818	8.3	Ht	838	13.0	My
814	11.6	Pb	799	9.7	Fc	840	13.4	Ie	830	7.0	Hf	X AUR			X GEM		
815	11.7	Hu	806	9.9	Ar	R COL			830	7.0	Wd	060450			064030		
815	11.6	Hf	807	9.6	Fn	*054629*			830	6.9	Dl	812	12.5	B	812	12.8	B
817	11.5	Wa	807	9.7	Si	776	13.3	Bl	830	6.5	Hm	829	10.5	Pt	838	12.3	Ie
820	11.4	Wa	807	10.0	Ar	798	[13.0	Ht	831	6.6	Bu	834	10.2	Fa	840	12.4	Wd
824	11.4	Wa	808	9.9	Ar	803	13.5	Fc	832	7.1	Dl	838	10.1	Fa			
826	12.0	Ar	813	9.9	Ar	811	[13.0	Ht	832	6.7	Hm						

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
Y MON			V CMI			R CMI			S CMI			S GEM			RT HYA		
065111			070109			070310			072708			073723			*082405*		
779	10.6	Fc	831	12.6	B	807	8.6	Si	831	9.2	B	838	11.7	Cm	829	9.2	Fr
803	12.2	Fc	839	11.9	Ra	814	8.6	Hf	833	8.8	Fn	840	11.4	B	829	8.0	Pt
813	13.1	Ar	840	13.1	Wd	814	9.3	Af	834	9.2	Dl	840	11.2	Jo	830	8.0	Bj
813	12.6	Hk	R GEM			814	9.3	Dh	835	9.3	Dl	841	11.3	Ie	833	8.7	Si
840	13.1	B	070122a			814	9.4	Fr	835	9.4	Wp	844	11.8	Wd	833	8.2	Lt
X MON			779	8.0	Fc	815	8.6	Hu	835	9.3	Wa	W PUP			837	8.6	Jo
065208			786	7.7	Ah	817	8.4	B	835	8.8	Ha	*074241*			838	8.2	My
803	7.3	Fc	805	7.7	Hk	829	8.6	Hk	837	9.3	Wm	776	11.8	Bl	841	8.6	Jo
807	7.6	Fn	805	7.7	Pb	829	7.2	Pt	838	9.0	Dl	784	12.8	Bl	841	8.4	Bj
807	7.9	Si	807	7.9	Hh	830	8.1	Jo	840	9.4	Wd	803	13.3	Bl	R CHA		
808	7.7	Si	807	7.5	Fr	834	8.4	Jo	840	8.8	Hf	803	12.9	Ht	*082476*		
813	8.0	Hk	811	7.7	Je	835	8.3	Wa	840	9.2	Dl	809	11.9	dK	777	13.1	Sl
813	7.6	Pb	813	7.0	Pb	835	8.5	Wp	841	9.0	Dl	811	11.6	Ht	811	[12.6	Ht
816	7.7	Si	814	7.4	Hf	837	8.2	Jo	841	8.9	Jo	816	11.2	dK	U CNC		
826	9.4	Hb	817	6.9	B	840	8.2	Jo	845	9.0	Dl	818	10.8	Ht	083019		
828	8.3	Hf	818	6.9	Ah	840	8.3	Wd	T CMI			823	10.9	dK	807	11.2	Ar
830	7.8	Fn	820	6.5	Wa	840	8.1	B	072811			T GEM			813	10.3	Hk
830	8.0	Jo	827	7.0	Wd	R VOL			779	10.6	Fc	074323			813	10.2	Pb
830	7.9	Si	827	7.4	Jo	*070772*			829	11.6	Hk	785	8.6	Fc	830	10.0	Jo
830	7.8	Bj	827	6.6	Hz	798	12.2	Ht	829	11.5	Pt	804	9.5	Pb	834	10.4	Cy
837	8.0	Jo	828	7.0	Hh	803	12.2	Ht	831	11.4	B	805	9.4	Pb	834	9.7	Jo
838	8.2	Hb	829	7.2	Ah	811	12.3	Ht	832	11.5	Bj	805	9.4	Hk	837	9.6	Jo
840	8.4	Hf	829	6.7	Pt	L_2 PUP			841	11.6	Ie	815	9.9	Hf	838	10.5	Hf
840	8.1	Wd	831	7.1	Bu	*071044*			842	11.6	Bj	829	10.4	Pt	841	10.0	Jo
841	8.2	Jo	833	6.8	Wa	776	3.9	Sl	Z PUP			830	11.0	Jo	X UMA		
R LYN			833	7.0	Wp	784	4.2	Sl	*072820b*			831	11.2	B	083350		
065355			834	7.3	Rb	839	5.3	Kd	833	9.0	Lt	834	11.1	Cy	813	[12.5	Pb
811	9.0	Je	834	7.3	Jo	840	5.3	Kd	S VOL			837	11.2	Jo	829	[12.5	Pt
813	9.3	Hk	835	7.1	Bu	RR MON			*073173*			838	11.8	Cm	S HYA		
829	9.9	Fr	837	7.6	Jo	071201			776	11.0	Bl	840	11.5	Jo	084803		
830	9.5	Jo	840	7.5	Jo	779	[12.3	Fc	784	11.5	Bl	841	11.3	Ie	813	8.3	Hk
830	9.7	Bj	840	7.0	B	807	14.9	Ar	798	12.5	Ht	844	12.0	Wd	813	8.0	Pb
837	9.9	Jo	845	7.5	Jo	813	14.9	Ar	803	13.4	Ht	U PUP			815	7.9	Hf
841	10.0	Ie	Z GEM			826	14.9	Ar	803	12.5	Bl	*075612*			829	9.4	Fr
842	10.0	Bj	070122b			829	14.9	Ar	811	[13.2	Ht	805	13.1	Hk	829	8.0	Pt
RS GEM			805	12.4	Hk	V GEM			U CMI			805	13.2	Pb	833	8.1	Cl
065530			805	12.4	Pb	071713			073508			813	13.3	Hk	834	8.2	Jo
785	11.4	Fc	827	12.3	Hz	804	8.1	Pb	817	9.1	B	813	13.3	Pb	837	8.0	Jo
804	11.1	Pb	827	12.4	Wd	813	8.3	Pb	829	9.4	Hk	R CNC			838	8.1	Hf
805	11.2	Pb	833	12.8	Wp	817	8.4	B	829	9.6	Pt	081112			841	8.0	Jo
805	11.2	Hk	833	12.9	Wa	826	9.1	Fr	830	9.7	Jo	813	10.7	Hk	845	8.1	Jo
807	11.2	Fr	834	12.6	Rb	829	9.2	Pt	834	9.6	Cy	813	10.9	Pb	T HYA		
830	10.6	Jo	TW GEM			830	8.9	Jo	838	9.7	Cy	828	10.2	Hz	*085008*		
834	12.0	Rb	070122c			837	9.2	Jo	840	10.2	Hf	829	9.9	Pt	813	8.0	Hk
837	10.5	Jo	805	8.4	Hk	840	9.4	Jo	840	9.3	B	829	10.2	Sq	813	8.0	Pb
840	10.5	Jo	805	8.4	Pb	845	9.8	Jo	840	9.7	Jo	830	10.7	Jo	815	8.0	Hf
845	10.7	Jo	807	8.7	Fr	S CMI			846	9.7	Cy	834	10.0	Cy	829	8.5	Pt
Z CMA			814	8.4	Hf	072708			S GEM			837	10.4	Jo	830	8.3	Bj
065911			814	8.3	Lt	779	11.5	Fc	073723			838	10.7	Hf	834	8.4	Cy
777	10.7	Sl	825	8.2	Lt	807	10.3	Fn	805	10.0	Pb	841	10.0	Jo	837	8.7	Jo
784	10.0	Sl	827	8.4	Wd	807	10.3	Si	805	10.0	Hk	845	10.2	Jo	838	8.9	Cy
V CMI			827	8.5	Hz	813	9.8	Fr	807	9.3	Fr	V CNC			838	9.2	Hf
070109			829	7.9	Pt	814	9.9	Hf	812	9.8	B	081617			841	8.8	Bj
785	9.8	Fc	R CMI			826	9.2	Ra	815	9.9	Hf	785	9.7	Fc	841	9.1	Jo
803	10.7	Fc	070310			827	9.1	Hf	829	10.0	Pt	813	11.3	Pb	T CNC		
814	11.8	Hf	779	9.5	Fc	829	9.2	Hk	830	10.6	Jo	813	11.1	Hk	085120		
829	12.6	Pt	803	8.8	Fc	829	8.6	Pt	834	11.7	Cy	829	11.7	Pt	813	10.4	Hk
829	12.6	Hk	807	8.8	Fn	830	9.3	Cm	837	10.9	Jo	834	12.0	Cy	813	10.3	Pb

Variable Star Observations Received During February, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
T Cnc			X Hya			R Leo			U UMa			R UMa			Z UMa		
085120			*093014*			094211			100860			103769			115158		
829	9.3	Pt	813	11.3	Pb	833	9.2	Dl	818	6.5	Lt	845	10.8	Dl	804	8.2	Kp
830	9.7	Jo	815	10.8	Hf	833	9.7	Kd	833	6.5	Lt	V Hya			813	8.0	Kp
834	10.2	Cy	829	9.9	Pt	834	9.7	Dl	Z Car			*104620*			814	8.3	Kp
834	9.5	Jo	830	10.0	Bj	835	10.2	Mc	*101058a*			776	6.8	Bl	815	8.3	Kp
837	9.5	Jo	838	10.0	Hf	835	9.6	Hm	784	[12.6	Bl	784	6.8	Bl	815	8.2	Hf
841	9.3	Jo	838	10.5	Hb	836	9.5	Kd	811	[12.6	Ht	803	6.9	Bl	827	8.1	Rb
T Pyx			838	9.7	Cy	837	9.8	Wm	W Vel			813	8.0	Hk	830	7.6	Rb
090031			840	10.0	Cm	837	9.5	Jo	*101153*			813	8.0	Pb	830	7.8	Kp
776	[13.0	Bl	842	9.7	Bj	838	9.7	Kd	784	11.9	Bl	829	6.2	Pt	832	7.6	Rb
V UMa			Y Dra			838	9.0	Ba	798	12.5	Ht	830	7.1	Si	833	7.8	Kp
090151			093178			838	9.5	Hm	803	12.1	Bl	830	7.0	Bj	834	7.6	Rb
827	10.5	Mc	837	11.9	Jo	838	9.7	Dl	803	12.8	Ht	833	7.4	Si	838	7.5	Rb
830	10.3	Jo	840	12.7	Ie	838	10.0	Wp	811	[13.0	Ht	843	7.8	Jo	840	7.2	Rb
834	10.2	Jo	841	11.6	Jo	838	9.8	Wa	U Hya			RS Hya			840	6.9	Hf
835	10.4	Mc	R LMi			838	9.6	Hf	*103212*			*104628*			841	7.4	Rb
837	10.2	Jo	093934			839	9.5	Kd	821	5.9	Kd	776	10.6	Bl	R Com		
841	10.4	Jo	829	12.6	Pt	840	9.5	Jo	830	5.9	Kd	784	11.1	Bl	115919		
W Cnc			R Leo			840	9.7	Dl	834	5.9	Kd	803	11.5	Bl	813	13.2	Ar
090425			094211			840	9.5	Hm	839	5.9	Kd	S Leo			813	12.5	Hk
829	12.6	Pt	773	7.0	Pg	840	9.9	Ha	RZ Car			110506			838	10.9	Hf
838	12.6	Cy	805	8.8	Pb	841	9.2	Ba	*103270*			817	9.9	Cy	840	10.9	Jo
RW Car			813	8.9	Kp	841	9.7	Dl	798	[13.6	Ht	829	11.1	Pt	SU Vir		
091868			813	8.9	Pb	845	9.7	Hm	811	[13.6	Ht	RY Car			120012		
784	10.9	Bl	813	9.2	Kd	845	10.0	Dl	R UMa			*111561*			829	[12.0	Pt
798	11.3	Ht	814	8.9	Sz	Y Hya			103769			784	13.0	Bl	T Vir		
803	12.6	Ht	815	9.1	Kp	*094622*			781	8.2	Ah	798	11.9	Ht	*120905*		
803	12.0	Bl	815	9.0	Hf	829	6.7	Pt	786	8.3	Ah	803	12.0	Ht	829	[12.5	Pt
811	12.7	Ht	815	9.1	Kd	Z Vel			804	9.2	Pb	803	11.8	Bl	R Crv		
Y Vel			816	8.7	Si	*094953*			804	8.9	Si	811	11.5	Ht	*121418*		
092551			817	9.0	Dl	784	[12.8	Sl	804	8.9	By	RS Cen			813	10.8	Hk
784	[12.9	Bl	818	8.7	Ah	811	[12.8	Ht	805	9.5	Pb	*111661*			813	10.8	Pb
798	[12.9	Ht	821	8.3	Hm	V Leo			807	9.9	Hh	784	11.3	Bl	817	10.3	Cy
811	[12.9	Ht	82*	9.5	Kd	095421			808	9.6	Pb	798	9.9	Ht	821	9.9	Kd
R Car			825	9.7	Kd	829	[12.6	Pt	813	9.6	Pb	803	9.4	Ht	829	9.5	Pt
092962			826	9.4	Kd	RR Car			814	9.6	Sz	803	9.2	Bl	833	9.3	Si
766	5.0	Df	827	9.3	Dl	*095458*			815	9.9	Hf	811	9.2	Ht	833	9.0	Bj
770	4.8	Df	827	8.5	Hm	798	7.6	Ht	821	9.7	Wd	818	9.3	Ht	836	9.3	Kd
775	4.6	Df	828	8.6	Hm	803	7.7	Ht	824	10.2	Hi	X Cen			838	8.8	Hf
776	4.7	Sl	828	9.7	Kd	811	7.6	Ht	827	10.3	Mc	*114441*			840	8.6	Kd
778	4.4	Df	829	9.3	Fr	818	7.7	Ht	827	10.6	Dl	776	7.8	Bl	RY UMa		
783	4.2	Df	829	9.3	Dh	RV Car			829	10.3	Pt	784	7.5	Bl	121561		
784	4.3	Sl	829	9.0	Pt	*095563*			830	10.4	Jo	803	7.0	Bl	814	7.5	Lt
784	4.3	Bl	829	9.2	Kd	784	[13.1	Bl	830	10.5	Ba	803	7.5	Ht	825	7.7	Lt
786	4.2	Df	830	8.9	Ba	811	[13.1	Ht	830	10.8	Cm	811	7.3	Ht	SS Vir		
792	4.3	Bl	830	9.4	Cm	S Car			830	10.5	Dl	818	7.6	Ht	122001		
795	4.2	Df	830	9.3	Fn	*100661*			833	10.8	Ra	AD Cen			813	9.3	Hk
798	4.4	Ht	830	9.3	Si	776	6.2	Sl	833	10.5	Dl	*114858*			813	9.1	Pb
802	4.5	Df	830	9.5	Wd	784	6.3	Sl	834	10.6	Dl	803	9.3	Ht	838	9.6	Hf
802	4.5	dK	830	9.0	Bj	784	6.5	Bl	834	10.4	Jo	811	9.3	Ht	T CVn		
803	4.2	Ht	830	9.3	Dl	798	7.7	Ht	835	10.7	Wm	818	9.3	Ht	122532		
803	4.3	Bl	830	8.6	Hm	802	7.5	dK	835	10.6	Ha	W Cen			813	10.8	Hk
809	4.8	dK	830	9.2	Jo	803	7.6	Bl	837	10.7	Jo	*115058*			817	10.4	Cy
811	4.7	Ht	830	9.6	Wm	803	8.0	Ht	838	10.7	Cy	784	[12.6	Bl	829	10.4	Pt
816	5.0	dK	830	9.7	Kd	809	8.0	dK	838	11.0	Wd	803	11.1	Bl	833	10.9	Bj
818	5.2	Ht	831	10.0	Mc	811	8.8	Ht	838	10.8	Ba	803	12.0	Ht	837	11.0	Jo
823	5.7	dK	832	9.8	Dl	816	8.6	dK	838	10.6	Dl	811	11.2	Ht	838	10.2	Cy
X Hya			833	9.8	Kp	818	9.2	Ht	840	10.7	Dl	818	10.5	Ht	841	10.7	Jo
093014			833	9.7	Wa	823	8.7	dK	841	10.9	Jo						
813	10.9	Hk	833	9.6	Wp				845	11.3	Jo						

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

J.D. Est. Obs.	J.D. Est. Obs.	J.D. Est. Obs.	J.D. Est. Obs.	J.D. Est. Obs.	J.D. Est. Obs.
Y VIR	RU VIR	R CVN	V BOO	Y LIB	R CRB
122803	124204	134440	142539a	*150605*	154428
833 11.5 Bj	813[11.8 Hk	813 9.9 Hk	817 8.2 Dl	818 12.6 Bj	813 8.9 Kd
836 11.2 My	837 11.9 Bj	834 10.1 Hl	829 8.1 Hk	842 13.7 Bj	813 8.9 Pb
U CEN	U VIR	834 10.4 Pt	832 8.4 Dl	S LIB	814 9.0 Hk
122854	124606	840 10.8 Hf	834 8.0 Cy	*151520*	814 8.8 Pb
784 10.5 Bl	834 8.9 Pt	RX CEN	834 8.0 Pt	817 9.8 Bj	817 9.6 Dl
803 8.5 Bl	RV VIR	*134536*	843 8.6 Jo	834 8.7 Pt	823 11.7 Kd
803 8.8 Ht	*130212*	811[13.1 Ht	845 8.6 Dl	844 8.8 Bj	824 11.9 Kd
811 8.2 Ht	813[13.3 Hk	T APS	R CAM	S SER	825 12.0 Kd
818 8.2 Ht	U OCT	*134677*	142584	151714	826 12.0 Kd
T UMA	*131283*	775 8.5 Bl	809 8.4 Hi	817 11.3 Bj	829 12.0 Kd
123160	784[12.9 Bl	784 9.4 Bl	824 8.7 Hi	844 11.8 Bj	829 12.0 Dh
813[12.3 Pb	811[13.2 Ht	798 10.1 Ht	829 9.6 Fr	S CRB	829 12.1 Ar
833 12.2 Bj	V CVN	803 10.5 Ht	830 8.5 Jo	151731	829 12.1 Hk
840 12.6 Jo	131546	803 10.2 Bl	834 8.6 Jo	817 10.7 Dl	830 10.9 Si
R VIR	837 7.3 Lt	811 10.8 Ht	837 8.8 Jo	834 11.0 Pt	832 10.0 Ah
123307	V VIR	RR VIR	840 9.0 Jo	RS LIB	833 11.0 Si
813 10.5 Hk	*132202*	*135908*	840 9.2 Wd	*151822*	834 12.1 Pt
834 8.7 Pt	814[10.5 Hk	834[12.8 Pt	845 9.3 Jo	815 9.8 Ht	834 11.4 Fa
834 9.1 Hl	R HYA	RU HYA	R BOO	RU LIB	835 12.0 Pt
RS UMA	*132422*	*140528*	143227	*152714*	836 11.7 Kd
123459	803 9.7 Ht	815 12.7 Ht	813 8.3 Pb	834[12.5 Pt	839 11.4 Kd
813 11.1 Ry	811 9.7 Ht	R CEN	814 8.5 Pb	R NOR	840 11.5 Kd
815 10.7 Hf	813 9.2 Kd	*140959*	815 8.8 Kp	*152849*	842 11.4 Pt
821 9.9 Wd	815 9.3 dK	784 9.2 Bl	829 9.4 Hk	815 8.9 Ht	843 10.9 Jo
827 9.7 Wd	821 9.6 Kd	801 8.0 dK	831 9.4 Si	S UMI	845 10.4 Wd
829 9.3 Ry	822 9.2 dK	803 8.0 Bl	833 9.5 Bj	153378	845 10.8 Dl
830 9.5 Jo	834 8.9 Pt	803 8.3 Ht	834 10.1 Pt	815 10.4 Hf	845 10.9 Cm
833 9.3 Bj	836 9.2 Kd	808 7.3 dK	V LIB	817 10.8 Dl	X CRB
833 9.5 Ra	S VIR	811 7.4 Ht	*143417*	827 10.9 Dl	154536
834 9.5 Pt	*132706*	815 7.0 dK	842[13.4 Bj	830 10.9 Dl	834[12.2 Pt
834 9.2 Jo	803 11.3 Ht	822 6.9 dK	S LUP	830 9.6 Jo	R SER
835 9.4 Mc	813 11.7 Pb	U UMI	*144646a*	832 10.9 Dl	154615
837 9.3 Jo	813 11.8 Hk	141567	815 11.2 Ht	833 10.9 Dl	805 7.6 Fn
838 9.4 Wd	815 11.3 Ht	781 8.6 Ah	X LUP	834 10.7 Dl	805 7.7 Si
840 9.6 Cm	834 11.8 Pt	786 8.7 Ah	*144646b*	834 10.1 Pt	817 8.1 Bj
840 9.3 Hf	837 12.2 Bj	805 8.4 Hk	815[12.1 Ht	837 9.7 Jo	833 8.7 Si
841 9.7 Dl	RV CEN	814 8.0 Sz	U BOO	838 10.9 Dl	834 8.8 Pt
841 9.3 Jo	*133155*	822 8.4 Ah	144918	840 10.9 Dl	844 8.9 Bj
845 9.1 Jo	784 8.9 Bl	830 8.3 Jo	829 11.5 Hk	840 10.1 Wd	V CRB
846 9.9 Cy	803 9.5 Bl	834 8.1 Jo	Y LUP	841 9.7 Jo	154639
S UMA	803 9.5 Ht	834 8.7 Pt	*145254*	845 10.6 Dl	825 9.7 Si
123961	811 10.0 Ht	837 8.5 Jo	784[12.4 Bl	U LIB	834 8.6 Pt
781 10.5 Ah	T UMI	840 9.0 Hf	815[12.8 Ht	*153620a*	845 9.6 Cm
813 10.8 Pb	133273	841 8.5 Jo	S APS	817 11.2 Bj	R LIB
815 11.3 Hf	805 13.1 Hk	S BOO	*145971*	T NOR	154715
827 10.8 Wd	805 12.4 Pb	141954	776[13.4 Bl	*153654*	842 12.0 Bj
830 11.0 Jo	T CEN	815 10.7 Hu	784[12.5 Bl	815 10.5 Ht	RR LIB
831 10.1 Mc	*133633*	834 9.5 Pt	803[13.4 Bl	RR CRB	*155018*
833 10.6 Ra	803 7.2 Ht	834 10.4 Jo	811[13.4 Ht	153738	834[12.7 Pt
833 10.7 Bj	811 7.2 Ht	837 10.0 Jo	815[13.4 Ht	833 8.2 Lt	T CRB
834 10.6 Pt	823 6.9 Kd	840 10.2 Jo	RT LIB	R CRB	155526
835 10.4 Mc	826 6.5 Lt	845 10.0 Jo	*150018*	154428	834 9.8 Pt
837 10.5 Jo	836 6.5 Kd	845 9.5 Wd	834[12.0 Pt	805 9.4 Fn	RZ SCO
840 10.2 Hf	RT CEN	RS VIR	T LIB	805 9.4 Si	*155823*
840 9.9 Cm	*134236*	142205	*150519*	805 8.6 Ar	815 9.3 Ht
841 10.2 Jo	803 10.4 Ht	813 12.5 Hk	842[13.0 Bj	805 9.4 Si	816 9.2 Bj
845 9.6 Jo	811 10.9 Ht	837 13.0 Bj		805 8.7 Pb	834 9.4 Pt
				807 8.3 Ar	

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
Z Sco			R UMi			RT Her			R Pav			S Lyr			RT Cyg		
160021			163172			170627			*180363*			190925			194048		
815[	12.0	Ht	805	9.4	Hv	835	12.6	Pt	815	9.4	Ht	842[	12.0	Pt	827	8.6	Jo
U Ser			805	9.2	Bc	Z Oph			T Her			X Lyr			827	8.8	Pt
160210			834	9.7	Jo	171401			180531			190967			830	8.5	Hf
817	8.9	Dl	835	9.8	Mc	835	12.6	Pt	833	7.4	Si	842	8.9	Pt	830	8.4	Cm
832	9.8	Dl	837	9.6	Jo	845	13.1	Cm	835	8.4	Pt	RS Lyr			834	8.4	Jo
834	8.9	Pt	838	9.6	Wd	RS Her			843	7.9	Jo	190933a			835	8.5	Mc
836	9.7	My	841	9.5	Jo	171723			W Dra			842[	12.5	Pt	840	8.3	Jo
843	9.5	Jo	R Dra			821	7.9	Bj	180565			RU Lyr			TU Cyg		
845	10.3	Dl	163266			835	8.6	Pt	835[	12.5	Pt	190941			194348		
SX Her			781	7.9	Ah	S Oct			RY Oph			842	11.6	Pt	827	9.2	Pt
160325			786	7.6	Ah	*172486*			181103			U Dra			830	9.3	Ry
833	8.1	Si	790	7.6	Ah	775	9.1	Bl	835	13.0	Pt	190967			830	9.7	Cm
833	8.1	Lt	804	7.9	Si	784	9.2	Bl	W Lyr			834	10.3	Jo	834	9.4	Jo
834	8.2	Pt	804	7.7	By	791	8.7	Bl	181136			837	10.2	Jo	840	9.6	Jo
835	8.0	Pt	805	7.8	Hv	798	8.8	Ht	781	8.7	Ah	840	10.0	Jo	χ Cyg		
842	7.9	Pt	805	7.9	Bc	802	9.0	Bl	786	8.8	Ah	842	10.0	Pt	194632		
RU Her			813	8.0	Kp	802	8.9	dK	790	8.9	Ah	RY Sgr			804	7.3	Kp
160625			815	7.9	Kp	803	8.9	Ht	793	9.2	Md	*191033*			804	6.8	Si
834[	12.4	Pt	821	8.0	Hm	809	8.8	dK	842	11.8	Pt	776	7.7	Bl	804	6.9	By
R Sco			827	8.0	Hm	811	9.3	Ht	RV Sgr			784	7.7	Bl	807	6.6	Si
161122a			827	8.3	Dl	816	9.1	dK	*182133*			791	7.4	Bl	814	5.9	Hf
815[	12.6	Ht	828	8.1	Hm	818	9.5	Ht	776	8.5	Bl	TZ Cyg			814	5.9	Kp
834[	12.0	Pt	830	7.9	Hm	823	9.2	dK	d Ser			191350			829	5.8	Kd
842	12.6	Bj	830	8.3	Kp	RU Oph			182200			807	10.7	Ar	830	5.1	Rb
S Sco			830	8.4	Dl	172809			833	5.1	Lt	813	10.7	Ar	830	5.3	Cm
161122b			833	8.8	Dl	835	12.6	Pt	T Ser			814	11.1	Ar	836	5.5	Kd
815[	12.6	Ht	833	8.3	Kp	842	12.4	Bj	182306			842	10.5	Pt	842	5.2	Ra
834[	12.0	Pt	834	8.2	Jo	RU Sco			842	11.5	Pt	UX Dra			RR Sgr		
842[	12.8	Bj	834	8.2	Pt	*173543*			X Oph			192576			*194029*		
W CrB			834	8.9	Dl	775	9.0	Bl	183308			814	6.7	Lt	776	7.7	Bl
161138			835	8.5	Hm	SV Sco			842	7.0	Pt	837	6.8	Lt	784	7.7	Bl
834[	12.5	Pt	837	8.3	Jo	*174135*			844	6.8	Bj	838	6.9	Lt	792	7.7	Bl
W Oph			838	8.7	Wd	775	8.8	Bl	RY Lyr			AF Cyg			RU Sgr		
161607			838	8.3	Hm	W Pav			184134			192745			*195142*		
834	12.2	Pt	838	9.2	Dl	*174162*			804	13.1	Pf	842	7.0	Ra	776	9.0	Bl
V Oph			840	9.1	Dl	815[	13.0	Ht	842[	12.5	Pt	R Cyg			784	9.0	Bl
162112			840	8.9	Hm	RS Oph			R Sct			193449			792	9.3	Bl
834	7.8	Pt	845	9.1	Hm	*174406*			*184205*			827	10.8	Mc	803	9.9	Bl
837	7.4	Bj	845	9.3	Dl	835	11.1	Pt	835	6.0	Pt	827	11.4	Jo	Nov Cyg		
U Her			S Her			837	11.5	Bj	839	5.8	Kd	827	10.6	Pt	195553		
162119			164715			U Ara			842	6.0	Pt	830	10.2	Cm	807	14.4	Ar
834	12.0	Pt	817	9.5	Dl	*174551*			845	6.1	Dl	834	10.4	Jo	813	13.8	Ar
843	11.8	Jo	834	10.0	Pt	815[	12.3	Ht	846	6.0	Cm	835	9.6	Mc	814	13.6	Ar
845	11.3	Cm	845	10.3	Cm	RT Oph			Nov Aql			840	9.6	Jo	Z Cyg		
g Her			RS Sco			175111			184300			845	9.4	Jo	195849		
162542			*164844*			835[	12.5	Pt	835	11.8	Pt	T Pav			827[	12.1	Pt
826	4.7	Lt	775	6.8	Bl	RY Her			RX Lyr			*193972*			S Tel		
836	4.9	Lt	815	7.8	Ht	175519			185032			776	11.3	Bl	*195855*		
SS Her			RR Sco			842	13.4	Bj	804[	13.4	Pf	784	11.6	Bl	803[	12.6	Bl
162807			*165030a*			UW Dra			842[	13.0	Pt	798	12.8	Ht	S Cyg		
834	12.0	Pt	815	7.0	Ht	175554			Z Lyr			803	13.1	Ht	200357		
W Her			RV Her			826	7.2	Lt	185634			803	13.4	Bl	827[	12.4	Pt
163137			165631			833	7.5	Lt	842[	12.7	Pt	811[	13.2	Ht	R Tel		
834	13.4	Pt	834[	13.3	Pt	V Dra			V Lyr			RT Cyg			*200747*		
R UMi			R Oph			175654			190529a			194048			803[	13.0	Bl
163172			*170215*			835[	12.7	Pt	842[	12.3	Pt	807	9.0	Si	RS Cyg		
804	9.7	Si	837	11.1	Bj							814	9.4	Hf	200938		
804	9.7	By										827	9.5	Mc	804	8.7	Si

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RS CYG			U CYG			R VUL			T CEP			RU CYG			R IND		
200938			201647			205923a			210868			213753			*222867*		
804	8.6	By	827	7.9	Jo	808	10.2	Fn	845	8.3	Dl	829	8.6	Pt	798	13.5	Ht
805	8.5	Hv	827	8.0	Pt	808	10.2	Si	845	7.9	Hm	830	8.4	Ry	803	13.5	Bl
805	8.4	Bc	830	8.1	Kp	814	9.8	Hf	846	8.3	Dl	834	8.7	Jo	803	13.5	Ht
807	8.9	Fn	830	8.0	Cm	830	8.1	Hf	846	7.7	Hm	835	9.0	Mc	811	13.5	Ht
807	8.9	Si	830	8.6	Hf	X CAP			Y PAV			837	8.7	Jo	W CEP		
807	9.3	Ar	832	8.6	Dl	*210221*			*211570*			840	8.5	Jo	*223257*		
807	9.3	Fr	834	8.7	Dl	769	12.4	Bl	798	6.0	Ht	845	8.5	Jo	826	8.5	Lt
813	9.3	Ar	834	7.8	Jo	X CEP			803	6.0	Ht	RV CYG			833	8.4	Lt
814	9.2	Fr	840	7.9	Jo	210382			811	6.2	Ht	213937			T TUC		
814	9.2	Af	845	8.7	Dl	777	11.7	Fc	818	6.4	Ht	829	6.5	Pt	*223462*		
814	9.0	Hf	U MIC			807	12.1	Hk	X PEG			μ CEP			798	13.3	Ht
827	9.2	Jo	*202240*			T CEP			211614			214058			810	12.8	Ht
827	9.1	Pt	776	10.8	Bl	210868			829	11.7	Pt	813	4.1	Lt	R LAC		
830	8.9	Hf	784	9.9	Bl	786	8.6	Ah	S MIC			838	4.0	Lt	223841		
830	9.1	Cm	792	9.3	Bl	804	7.6	By	*212030*			R GRU			819	12.5	Bs
834	9.1	Jo	803	9.2	Bl	804	7.5	Si	776	10.2	Bl	*214247*			S AQR		
RT SGR			ST CYG			806	8.1	Si	784	11.0	Bl	776	11.5	Bl	*225120*		
201139			202954			807	8.0	Hk	792	11.4	Bl	784	11.9	Bl	807	8.1	Fr
776	8.6	Bl	827	11.0	Pt	808	8.3	By	803	12.5	Bl	799	12.4	Ht	RW PEG		
784	8.9	Bl	830	10.5	Hf	811	8.1	Je	W CYG			803	12.3	Bl	225914		
792	9.3	Bl	834	10.7	Jo	813	8.1	Pb	213244			803	12.5	Ht	808	12.8	Wu
803	9.7	Bl	R MIC			813	8.0	Fr	822	5.9	Kd	VV CEP			817	13.1	Wa
WX CYG			*203420*			814	8.0	Pb	827	6.0	Mc	215363			829	13.8	Bs
201437b			776	9.3	Bl	815	8.3	Hb	831	6.2	Mc	828	5.5	Lt	R PEG		
807	10.8	Ar	784	9.6	Bl	817	8.1	Rb	834	6.2	Mc	833	5.5	Lt	230110		
807	10.6	Fr	792	9.2	Bl	819	8.0	Bs	835	6.1	Mc	TW PEG			815	11.3	Hf
813	10.8	Ar	803	10.1	Bl	820	8.0	Hf	837	6.2	Mc	215927			829	12.0	Pt
814	10.8	Ar	V CYG			821	8.0	Hm	838	5.9	Kd	825	8.4	Lt	V CAS		
814	10.6	Fr	203847			821	8.1	Dl	S CEP			RZ PEG			230759		
814	10.7	Af	829	12.5	Pt	821	7.6	Wd	213678			*220133b*			804	8.8	Si
814	9.8	Hf	Y AQR			823	8.9	Hb	814	11.1	Fr	821	9.5	B	804	8.9	By
827	10.0	Jo	*203905*			827	8.2	Dl	814	11.1	Af	S GRU			807	8.7	Fn
830	9.6	Hf	807	10.4	Fr	827	8.0	Hm	825	9.0	Dt	*221948*			808	8.5	Kn
830	10.8	Rb	808	10.1	Si	827	7.7	Jo	826	9.0	Dt	799	9.6	Ht	813	8.3	Hk
830	10.0	Wd	U CAP			829	7.9	Pt	827	9.0	Dt	802	9.3	dK	813	8.4	Pb
834	10.6	Jo	*204215*			830	8.2	Cm	827	10.1	Jo	803	9.7	Ht	814	8.6	Fr
V SGE			776	11.0	Bl	830	8.4	Dl	828	9.0	Dt	809	9.5	dK	814	8.5	Af
201520			V DEL			830	7.6	Hm	829	9.8	Pt	810	9.7	Ht	814	8.4	Hf
777	12.0	Fc	204318			830	7.6	Rb	830	11.0	Ba	815	10.0	Ht	816	8.8	Fn
U CYG			777	11.6	Fc	830	8.0	Hf	834	11.1	Cm	816	9.8	dK	816	8.9	Si
201647			T AQR			830	8.0	Ba	834	10.0	Jo	823	10.0	dK	819	8.7	Bs
804	7.8	Si	*204105*			832	8.3	Cm	834	9.0	Dt	S LAC			820	8.6	B
804	7.7	By	770	10.0	Pg	833	8.2	Dl	835	9.0	Dt	222439			822	8.6	Ah
805	7.8	Hv	773	9.8	Pg	834	7.8	Hb	836	11.3	Ra	793	7.6	Md	829	7.8	Pt
805	7.8	Bc	808	8.1	Si	834	7.5	Jo	837	10.2	Jo	808	8.1	Si	830	8.0	Hf
806	7.7	Si	RZ CYG			834	8.2	Dl	838	10.8	Ba	808	8.1	Fn	830	8.2	Jo
811	7.8	Je	204846			835	8.0	Hm	838	11.0	Cy	814	9.0	Fr	834	8.0	Jo
813	9.3	Fr	829	10.3	Pt	835	7.4	Mc	841	10.2	Jo	814	9.0	Af	837	8.0	Jo
813	9.3	Af	S IND			838	7.7	Hm	844	9.0	Dt	814	8.5	Hf	838	8.5	Cy
814	9.2	Af	*204954*			838	8.2	Dl	845	10.4	Jo	816	8.8	Fn	841	7.8	Jo
814	9.6	Fr	776	8.6	Bl	838	8.0	Wd	RU CYG			821	8.6	B	845	7.8	Jo
814	7.6	Kp	784	9.1	Bl	838	7.9	Ba	213753			830	9.4	Hf	W PEG		
814	8.6	Hf	792	8.8	Bl	840	8.2	Dl	805	8.6	Cl	836	9.5	Md	231425		
815	7.8	Kp	799	9.0	Ht	840	7.5	Hm	807	8.7	Si	R IND			814	9.9	Hf
821	8.1	Wd	803	9.2	Bl	841	8.0	Hm	811	8.9	Je	*222867*			816	9.3	Cl
822	8.2	Ah	803	9.1	Ht	841	7.8	Rb	816	8.6	Cl	776	11.5	Bl	816	9.5	Fn
827	8.7	Mc	811	9.6	Ht	841	7.6	Jo	827	9.3	Mc	784	11.9	Bl	827	8.7	Jo
827	8.7	Dl				845	7.3	Jo	827	8.8	Jo	792	12.4	Bl	829	10.5	Fr

Variable Star Observations Received During February, 1935.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
W Peg			**Z And**			**ST And**			**R Aqr**			**R Cas**			**R Cas**		
231425			*232848*			*233335*			*233815*			*235350*			*235350*		
830	9.3	Hf	813	10.7	Pb	830	9.0	Hf	824	10.6	Kd	811	9.2	Je	838	10.0	Dl
833	9.3	Cl	813	10.6	Ar	830	8.9	Jo	827	11.3	Jo	813	9.4	Hk	840	10.0	Dl
833	9.3	Fn	814	10.7	Ar	834	9.0	Jo	830	11.5	Jo	813	9.5	Pb	841	9.4	Jo
834	8.7	Jo	814	10.6	Hf	837	8.9	Jo	830	11.0	Bj	814	9.7	Pb	845	9.8	Jo
840	8.4	Jo	814	10.7	Pb	840	8.7	Jo	**Z Cas**			814	9.4	Hf	**Z Peg**		
845	8.2	Jo	826	10.7	Ar	845	8.8	Jo	*233956*			814	9.5	Fr	*235525*		
S Peg			826	10.6	Pb	**R Aqr**			829	14.3	Mg	814	9.6	Af	829	11.3	Pt
231508			829	10.7	Pb	*233815*			**RR Cas**			815	9.0	Kp	**WZ Cas**		
815	11.4	Hf	829	10.3	Pt	776	10.7	Bl	*235053*			820	9.1	B	*235659*		
829	12.1	Pt	829	10.6	Ar	777	10.5	Sl	814[	12.6	Pb	821	9.5	Kp	757	7.8	Lt
V Phe			830	10.6	Hf	784	10.7	Bl	**V Cep**			821	9.5	Wd	795	7.5	Lt
232746			836	10.7	Md	792	10.9	Bl	*235182*			830	8.9	Jo	837	7.9	Lt
799[	13.2	Ht	845	10.9	Jo	799	10.8	Ht	817	6.4	Lt	830	9.7	Hf	**Y Cas**		
811[	13.2	Ht	**ST And**			803	10.9	Bl	**V Cet**			833	9.6	Si	*235855*		
Z And			*233335*			803	10.9	Ht	*235209*			833	10.1	Dl	813[	13.3	B
232848			814	8.7	B	804	10.8	Si	803	11.5	Bl	834	9.2	Cm	**SV And**		
804	10.6	Pb	814	9.1	Hf	806	10.8	Si	807	11.2	Fr	834	10.2	Dl	*235939*		
805	10.7	Pb	819	9.2	Bs	807	11.1	Fr	**R Tuc**			834	9.0	Jo	809	13.3	Be
806	10.7	Pb	826	9.5	Fr	808	10.8	By	*235265*			837	9.4	Jo	829	13.6	Mg
807	10.7	Ar	829	8.8	Mg	810	10.8	Ht	782	13.4	Sl	838	9.9	Wd			
808	10.7	Pb	829	9.5	Pt	815	11.0	Ht	811[	13.3	Ht						

Rapidly Varying Irregular Variables.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840 RX Andromedae—						
	7805.6	12.9	Es	7829.6	12.5	Pt
	7807.4	11.0	Ry	7830.3	12.1	Ry
	7807.6	10.7	Ar	7831.4	11.6	Ry
	7809.3	11.5	Be	7833.6	11.1	Pt
	7809.6	11.6	Wu	7834.6	11.5	Cy
	7813.6	13.1	Ar	7834.6	12.0	Fa
	7814.7	12.9	Ar	7837.6[	12.0	Jo
	7821.4	11.0	Ry	7838.6	12.8	Fa
	7826.6	12.7	Ar	7838.6	12.2	Wa
	7827.6	12.4	Pt	7838.6	12.1	Cy
	7828.6	12.1	Pt	7846.6	11.3	Wd
	7829.5	12.2	Ar			
060547 SS Aurigae—						
	7805.9	13.9	Ar	7826.6	14.9	Ar
	7806.8	13.8	Ar	7827.7[	13.9	Hi
	7807.6	14.2	Ar	7828.8[	13.9	Hi
	7807.8	14.2	Ar	7829.5	14.5	Ar
	7808.7	14.7	Ar	7830.5[	13.9	Wa
	7809.6[	13.9	Hi	7831.4[	13.8	Ry
	7813.6	11.3	Ry	7832.5	14.2	Wa
	7813.6	10.9	Ar	7833.5	14.3	Wa
	7813.7	10.8	Ar	7834.5[	13.9	Wa
	7814.7	11.1	Ar	7835.7[	14.5	Hi
	7815.7	11.2	Hu	7836.5[	13.2	Wp
	7817.5	12.8	Wa	7838.5	14.2	Wa
	7820.5[	13.2	Wa	7842.8[	12.5	Pt
	7824.7[	13.2	Hi			
074922 U Geminorum—						
	7805.7	11.7	Ar	7807.8	13.4	Ar
	7805.8	11.7	Hk	7807.9	14.0	Ar
	7805.8	11.7	Pb	7808.6	13.8	Wu
	7806.7	12.7	Ar	7808.9	14.0	Ar
	7807.6	13.6	Ar	7812.6[	13.8	B
074922 U Geminorum—						
	7813.6	14.0	Ar	7833.6[	13.8	Wa
	7815.6[	13.3	Hf	7834.6[	13.9	B
	7817.9[	12.4	Cy	7834.6	13.8	Wu
	7826.7	14.1	Ar	7835.7[	12.4	Pt
	7827.7[	13.3	Pt	7836.7[	12.4	Pt
	7828.7[	13.3	Pt	7838.5	13.6	Wp
	7829.6	14.0	Ar	7838.5[	13.8	Wa
	7829.7	13.8	Ar	7840.0[	13.8	B
	7830.5[	13.8	Wp	7841.7[	13.3	Bj
	7831.5[	13.5	B	7843.7[	12.4	Pt
	7832.7[	12.4	Pt	7844.6[	12.6	Wd
081473 Z Camelopardalis—						
	7805.6	12.7	Es	7833.7	11.5	Pt
	7807.5	12.8	Ry	7834.5	11.4	Wa
	7807.6	12.3	Ar	7834.6	11.9	Fa
	7813.6	12.9	Ry	7834.7	11.3	Cy
	7813.6	12.9	Ar	7834.6	11.5	Jo
	7813.7	12.9	Ar	7834.7	11.5	Pt
	7814.7	13.0	Ar	7835.6	11.7	Wp
	7815.7	13.0	Hu	7835.6	11.7	Wa
	7817.9	12.0	Cy	7835.7	11.6	Pt
	7821.4	11.1	Ry	7836.5	12.1	Wa
	7826.6	11.7	Ar	7836.6	12.2	Wp
	7826.7	12.1	Pt	7836.7	11.6	Md
	7828.5	12.2	Ry	7837.6	11.6	Jo
	7828.7	12.1	Pt	7838.6	12.3	Fa
	7829.7	12.3	Pt	7838.5	12.1	Wa
	7829.9	12.2	Ar	7838.6	12.1	Cy
	7830.4	11.9	Ry	7838.6	12.2	Wp
	7830.6	11.8	Jo	7840.7	12.1	Md
	7831.4	11.6	Ry	7841.6	11.7	Jo
	7832.6	12.3	Pt	7838.7	12.8	Pt
	7833.5	11.7	Wa	7842.9	12.0	Pt
	7833.6	11.5	Wp			

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
094512 X LEONIS—						
	7807.8	15.3	Ar	7829.7	12.6	Pt
	7813.7	14.6	Ar	7834.7	12.6	Pt
	7828.7	12.4	Pt			
180445 NOVA HERCULIS—						
	7787.4	3.0	Rd	7805.9	3.2	Si
	7789.4	2.8	Rd	7806.0	2.7	Ar
	7790.2	2.5	Ah	7806.0	2.8	Ha
	7790.4	2.8	Rd	7806.0	3.4	Si
	7792.2	2.1	Ah	7806.4	2.1	Rd
	7792.4	1.9	Rd	7806.4	2.9	Hu
	7793.2	2.0	Ah	7806.5	2.7	Hv
	7793.5	1.0	Nt	7806.5	2.6	Jb
	7793.7	1.0	Nt	7806.5	2.7	Pb
	7795.2	2.2	Be	7806.5	2.7	Ar
	7796.5	2.0	Rd	7806.5	3.3	By
	7796.7	2.7	Nt	7806.5	2.6	Sa
	7796.7	2.8	Nt	7806.5	2.7	Dh
	7798.0	2.1	Ha	7806.5	2.6	Hk
	7798.5	3.1	Rd	7806.5	3.4	Si
	7799.0	2.1	Ha	7806.6	2.7	Bc
	7799.4	2.0	Rd	7806.6	2.8	Hi
	7801.2	2.8	Ah	7807.0	2.6	Ha
	7701.4	2.9	Rd	7807.0	2.7	Hk
	7802.2	2.9	Be	7807.0	2.6	Jb
	7802.4	2.2	Rd	7807.2	2.8	L
	7802.5	2.8	Ha	7807.4	2.0	Ch
	7803.4	2.1	Rd	7807.4	2.1	Rd
	7804.0	2.5	Si	7807.5	2.7	Nt
	7804.2	2.4	By	7807.5	2.7	Si
	7804.4	2.2	Hu	7807.5	2.6	Ha
	7804.5	2.7	Lf	7807.5	2.7	Ah
	7804.5	2.7	Pb	7807.5	2.4	Hu
	7804.5	2.7	Dh	7807.5	2.6	Jb
	7804.5	2.4	Rd	7807.5	2.6	Hk
	7804.5	2.6	By	7807.5	2.7	Ar
	7804.5	2.8	Kp	7807.5	2.5	Hv
	7804.5	2.6	Si	7807.5	2.2	Sa
	7804.5	2.7	Ar	7807.5	2.7	Fr
	7804.5	2.7	Hv	7807.6	2.6	Bc
	7804.5	2.8	Fr	7807.6	2.8	Si
	7804.6	2.7	By	7807.6	2.9	Pf
	7804.6	2.7	Bc	7807.6	2.8	Nt
	7804.9	2.8	Si	7808.0	2.7	Ar
	7805.0	2.5	Ha	7808.2	2.8	Be
	7805.2	2.9	L	7808.4	2.1	Rd
	7805.5	2.3	Rd	7808.5	2.4	Ha
	7805.5	2.6	Jb	7805.5	2.7	Ah
	7805.5	2.6	Ar	7808.5	2.4	Hv
	7805.5	2.7	Hv	7808.5	2.6	Ar
	7805.5	2.7	Fr	7808.5	2.3	Hu
	7805.5	2.6	Ah	7808.5	2.5	Pb
	7805.5	2.6	Ch	7808.5	2.6	Af
	7805.5	3.0	Si	7808.5	2.6	Hk
	7805.5	2.5	Ha	7808.5	2.7	Si
	7805.5	2.6	Pb	7808.6	2.6	Bc
	7805.5	2.6	Lf	7808.6	2.6	Hi
	7805.6	2.8	Pf	7808.9	2.7	Si
	7805.6	2.6	Sq	7809.3	2.8	L
	7805.6	2.7	Bc	7809.5	2.5	Hu
180445 NOVA HERCULIS—						
	7809.5	2.4	Hv	7815.5	2.3	Kp
	7809.5	2.6	Dh	7815.5	3.0	Hu
	7809.5	2.1	Ch	7815.5	2.1	Ch
	7809.5	2.5	Hk	7815.5	2.6	Nt
	7809.5	2.6	Pb	7815.5	2.7	Si
	7809.6	2.6	Hi	7815.5	1.9	Hf
	7810.0	2.8	Ha	7815.6	2.5	Hi
	7810.5	2.7	Nt	7816.0	2.7	Nt
	7810.5	2.7	Mg	7816.1	2.1	Ra
	7811.5	2.2	Ch	7816.2	2.8	Be
	7811.5	2.8	Mg	7816.6	2.5	Pf
	7812.3	2.1	Kd	7816.6	2.6	Nt
	7812.5	2.8	Nt	7816.9	2.4	Hk
	7812.5	2.8	Mg	7817.1	2.0	Ra
	7812.6	2.7	Nt	7817.1	2.4	Nt
	7812.8	2.9	Hu	7817.4	2.4	Rb
	7812.9	2.4	Kd	7817.5	2.6	Hv
	7813.0	3.0	Hk	7817.5	2.3	Kg
	7813.5	3.0	Ar	7817.5	2.4	Ba
	7813.5	2.4	Hv	7817.5	2.4	Wa
	7813.5	3.0	Dh	7817.5	2.0	Hf
	7813.5	2.4	Ch	7817.5	2.3	Wd
	7813.5	2.8	Hk	7817.7	2.3	L
	7813.5	3.1	Pb	7817.9	2.0	Dl
	7813.5	2.7	Hu	7817.9	2.3	Kd
	7813.6	2.7	Hi	7817.9	2.3	Ie
	7813.9	1.9	Kd	7817.9	2.3	Hk
	7813.9	2.7	Hk	7817.9	1.9	Rb
	7814.0	2.6	Si	7818.0	2.4	Jb
	7814.0	2.5	Jb	7818.1	2.0	Ra
	7814.0	2.8	Ha	7818.2	2.7	Ah
	7814.0	2.3	Rb	7818.5	3.0	Dh
	7814.1	2.2	Ra	7818.5	2.6	Hk
	7814.3	2.1	Kd	7818.5	2.3	Sf
	7814.4	2.2	Rd	7818.5	2.8	Bc
	7814.4	2.6	Rb	7818.6	2.8	Hi
	7814.5	2.6	Jb	7818.7	2.8	L
	7814.5	2.5	Kp	7818.9	2.3	Kd
	7814.5	2.7	Ar	7819.0	2.7	Cm
	7814.5	2.9	Hu	7819.0	2.7	Jb
	7814.5	2.8	Sa	7819.1	2.6	Ra
	7814.5	2.9	Dh	7819.4	3.4	Bs
	7814.5	2.7	Hk	7819.5	2.1	Kp
	7814.5	2.4	Hf	7819.5	2.5	Hv
	7814.5	2.6	Pb	7819.5	2.2	Hm
	7814.6	2.6	Hi	7819.6	2.3	Pf
	7814.6	2.7	Fr	7820.0	2.5	Ha
	7814.6	2.4	Ra	7820.0	2.4	Hk
	7814.9	2.2	Kd	7820.0	2.6	Fn
	7814.9	2.1	Rb	7820.1	2.0	Ra
	7815.0	2.6	Mg	7820.3	1.8	Kd
	7815.0	2.6	Ha	7820.5	2.5	Pb
	7815.0	2.5	Jb	7820.5	2.3	Hu
	7815.1	2.1	Ra	7820.5	2.4	Dh
	7815.4	2.4	Rb	7820.5	2.5	Bc
	7815.4	2.0	Rd	7820.5	2.3	Wa
	7815.4	2.1	Kd	7820.5	2.0	Hf
	7815.4	2.2	Sa	7820.5	2.4	Wd
	7815.5	2.4	Jb	7820.9	1.8	Kd

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
180445	NOVA HERCULIS—				180445	NOVA HERCULIS—			
	7820.9	1.9 Ba	7826.5	3.0 Hu		7830.9	2.5 Sf	7837.0	3.2 Mg
	7821.0	2.2 Nt	7826.5	2.8 Bf		7830.9	2.6 Si	7837.3	3.0 Kd
	7821.1	1.9 Ra	7826.5	3 ? Dh		7830.9	1.9 Rb	7837.7	3.5 Pt
	7821.2	1.6 Kd	7826.5	2.7 Pb		7831.6	3.0 Mc	7838.0	3.3 Cm
	7821.4	2.3 Rb	7826.5	2.6 Lf		7831.8	2.8 Si	7838.4	3.6 Rb
	7821.4	1.9 Rd	7826.6	2.6 Bc		7831.9	2.8 Pb	7838.4	2.8 Kd
	7821.5	2.0 Dl	7826.8	3.0 Hk		7832.4	3.0 Rb	7838.5	3.6 Hm
	7821.5	2.1 Hm	7826.9	2.6 Jb		7832.5	3.4 Hm	7839.4	2.2 Kd
	7821.5	1.9 Hf	7826.9	2.7 Hk		7832.6	2.4 Ah	7839.8	2.5 To
	7821.5	2.6 Wa	7827.0	2.6 Ha		7832.8	3.6 Rb	7839.9	2.8 SG
	7821.5	2.3 Kp	7827.1	2.1 Ra		7832.8	3.6 Ba	7840.0	2.7 Mg
	7821.5	2.4 Wd	7827.4	2.2 Rd		7832.9	3.5 Dl	7840.0	2.6 Rb
	7821.5	2.4 Nt	7827.4	2.6 Rb		7832.9	3.5 Ie	7840.4	3.4 Rb
	7821.5	1.9 Kg	7827.4	1.9 Kd		7832.9	3.7 Sf	7840.4	2.2 Kd
	7821.6	1.9 Ba	7827.5	2.5 Sf		7832.9	3.0 Hk	7840.5	4.0 Hm
	7821.9	2.1 Bj	7827.5	2.6 Wa		7832.9	3.6 Si	7840.8	2.9 Ie
	7821.9	1.4 Rb	7827.5	2.0 Hm		7833.0	3.9 Cm	7840.9	2.6 SG
	7822.1	2.4 Nt	7827.5	2.1 Dl		7833.0	3.1 Hk	7840.9	2.8 Sf
	7822.1	1.9 Ra	7827.6	3.0 Mc		7833.0	2.9 Hk	7840.9	3.4 Pt
	7822.6	2.6 Hi	7827.8	2.0 Rb		7833.4	3.6 Rb	7841.0	2.5 Jb
	7822.6	2.1 Ah	7827.9	2.3 Ie		7833.5	3.8 Jb	7841.0	2.8 Bz
	7823.1	2.1 Ra	7827.9	2.3 Si		7833.5	3.3 Hm	7841.0	2.7 Ha
	7823.2	2.7 Be	7827.9	2.3 Ba		7833.8	3.6 Ba	7841.0	2.9 Cm
	7823.2	2.5 Ah	7827.9	2.8 Pt		7833.8	4.0 Si	7841.8	2.6 Hj
	7823.3	1.9 Kd	7828.0	2.6 Cm		7833.9	3.7 Pt	7841.9	3.0 Bz
	7823.6	2.8 Hi	7828.1	2.1 Ra		7833.9	4.0 Si	7842.1	2.8 Ra
	7824.4	1.8 Kd	7828.4	2.6 Rb		7834.0	3.8 Fn	7842.9	2.5 Bj
	7824.5	2.6 Pb	7828.5	2.4 Dh		7834.0	3.7 Mg	7842.9	2.4 Pt
	7824.5	2.8 Mg	7828.5	2.1 Hm		7834.0	3.8 Hh	7843.1	2.6 Bz
	7824.5	2.6 Ar	7828.6	2.7 Hi		7834.1	3.7 Hi	7843.8	2.6 Jo
	7824.5	2.5 Hv	7829.0	2.2 Mg		7834.1	3.8 Ra	7843.8	3.0 SG
	7824.5	2.5 Hk	7829.1	1.8 Ra		7834.4	3.2 Rb	7844.9	3.1 Bj
	7824.5	2.3 Hu	7829.4	1.9 Kd		7834.4	3.3 Kd	7844.9	3.2 SG
	7824.5	2.4 Dh	7829.5	2.6 Ar		7834.5	3.8 Jb	7845.0	3.0 Cm
	7824.6	2.8 Hi	7829.5	2.6 Fr		7834.5	3.1 Hm	7845.5	3.1 Hm
	7824.6	2.5 Bc	7829.5	2.6 Hk		7834.6	3.3 Mc	7845.8	3.3 Ie
	7824.8	2.4 Hk	7829.5	2.6 Dh		7834.7	3.4 Pt	7845.8	2.9 Wf
	7824.9	2.1 Pb	7829.5	2.6 Pb		7834.8	2.8 Cy	7845.9	2.6 Sf
	7825.0	2.0 Ar	7829.8	2.6 Hk		7834.8	2.4 Rb	7845.9	3.0 Cm
	7825.0	2.4 Hk	7829.8	2.5 Dh		7834.8	3.3 Ie	7845.9	2.7 Dl
	7825.4	2.1 Kd	7829.9	2.4 Fr		7834.8	3.4 Ba	7845.9	3.3 SG
	7825.5	2.6 Pb	7829.9	2.4 Ar		7834.9	3.3 Sf	7846.8	2.5 Bi
	7825.5	2.9 Mg	7829.9	2.4 Dh		7835.0	3.1 Cm	7846.9	2.5 Sf
	7825.5	2.6 Ar	7829.9	2.3 Si		7835.0	3.3 Ha	7846.9	3.3 Ie
	7825.5	2.7 Si	7829.9	2.6 Hk		7835.0	3.2 Mg	7847.9	2.8 Pt
	7825.6	2.7 Hi	7830.0	2.4 Hk		7835.1	3.3 Hi	7847.9	2.6 SG
	7825.6	3.0 Pf	7830.0	2.3 Dh		7835.1	3.6 Ra	7849.8	3.5 Wf
	7825.8	2.6 Hk	7830.4	2.4 Rb		7835.5	3.1 Hm	7849.9	2.9 Ba
	7825.9	2 0 Pt	7830.4	2.6 Kd		7835.6	3.5 Mc	7849.9	3.3 SG
	7826.0	3.0 Ha	7830.5	2.4 Pb		7835.6	3.0 Wm	7851.8	2.8 SG
	7826.0	2.6 Ar	7830.5	2.2 Hm		7835.8	3.7 Rb	7853.9	3.6 SG
	7826.0	2.6 Hk	7830.5	2.3 Hf		7835.9	3.8 Pt	7854.8	3.5 To
	7826.1	2.8 Ra	7830.5	2.1 Kg		7836.0	3.5 Ha	7854.9	3.3 SG
	7826.2	1.7 Kd	7830.5	2.5 Ba		7836.0	3.7 Bz	7855.9	3.5 SG
	7826.5	2.6 Hv	7830.5	2.5 Wa		7836.1	3.7 Ra	7857.9	3.0 SG
	7826.5	2.6 Fr	7830.5	2.6 Cm		7836.3	2.9 Kd	7858.8	3.0 Wf
	7826.5	2.9 Hu	7830.8	2.7 Si		7836.9	3.5 Pt	7858.9	2.7 SG
	7826.5	2.7 Hk	7830.9	2.5 Hk		7837.0	3.1 Bz		

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1935.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
202946 SZ CYGNI—						
	7827.6	9.6	Pt	7835.6	9.2	Pt
	7828.6	9.6	Pt	7836.7	9.0	Pt
	7829.6	9.6	Pt	7837.7	9.0	Pt
	7832.7	9.7	Pt	7838.7	9.1	Pt
	7833.7	8.9	Pt	7842.9	9.6	Pt
	7834.7	9.0	Pt			
213843 SS CYGNI—						
	7780.6	10.2	Kn	7814.5	12.1	Pb
	7781.2	9.4	Ah	7814.5	12.0	Hf
	7781.6	9.3	Kn	7817.5	12.0	Hf
	7786.2	8.9	Ah	7817.5	12.2	Wa
	7805.6	12.1	Hk	7819.5	12.2	Bs
	7805.6	12.0	Hv	7820.5	12.1	Wa
	7805.6	11.8	Bc	7821.5	11.8	B
	7806.9	12.1	Pb	7825.6	11.0	Si
	7807.6	12.0	Ar	7826.5	12.1	Pb
	7807.6	12.0	Fr	7826.5	12.1	Fr
	7808.5	12.2	Pb	7826.6	11.9	Ar
	7808.6	12.0	Kn	7826.6	11.9	Pt
	7809.5	12.1	Pb	7826.7	12.0	Hu
	7811.5	12.0	B	7827.5	11.9	Jo
	7813.5	12.0	Pb	7827.5	12.2	Rb
	7813.6	11.9	Hk	7827.6	11.0	Mc
	7813.6	12.0	Ar	7827.6	11.9	Pt
	7813.6	11.9	Fr	7828.6	12.0	Mg
	7814.5	12.0	B	7828.6	11.7	Pt
	7814.5	12.0	Ar	7839.5	12.0	Pb
	7814.5	12.1	Fr	7829.5	11.9	Ar
213843 SS CYGNI—						
	7829.6	12.0	Fr	7835.5	12.2	Rb
	7829.6	12.1	Mg	7835.6	11.7	Pt
	7829.7	11.7	Pt	7836.5	12.0	Wp
	7830.5	12.0	Jo	7836.5	11.9	Wa
	7830.5	12.2	Rb	7836.6	12.0	Ra
	7830.5	11.8	Wd	7836.6	11.7	Pt
	7830.5	12.0	Wa	7837.5	11.7	Wa
	7830.5	11.9	Wp	7837.5	11.9	Jo
	7831.6	11.6	Bj	7838.5	11.5	Cm
	7832.5	12.0	B	7838.5	11.3	Wd
	7832.5	12.0	Cm	7838.5	11.9	Wa
	7832.5	11.9	Wa	7838.5	12.0	Wp
	7832.5	12.2	Rb	7838.5	11.8	Rb
	7832.6	11.7	Pt	7838.7	11.7	Pt
	7833.5	12.2	Rb	7839.6	12.0	Ra
	7833.5	12.0	Wp	7840.5	8.7	Cm
	7833.5	12.1	Wa	7840.5	9.3	Jo
	7833.6	11.8	Bj	7840.5	9.2	Rb
	7833.6	11.7	Pt	7840.5	9.2	Hf
	7834.5	11.7	B	7841.5	8.2	Rb
	7834.5	11.9	Wa	7841.5	9.0	Jo
	7834.5	12.0	Rb	7842.9	8.8	Pt
	7834.5	12.0	Jo	7844.5	8.4	Cm
	7834.5	11.7	Cm	7845.5	8.6	Jo
	7834.6	11.7	Pt	7846.5	8.2	Wa
	7835.5	11.7	B	7846.5	8.3	Wp
	7835.5	11.8	Wa	7846.5	8.3	Cm
	7835.5	11.8	Wp			

SUMMARY FOR FEBRUARY, 1935.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	18	48	Frister	Fr	53	98
Armfield, D.	Af	25	36	Friton	Fn	19	34
Armfield, L.	Ar	35	141	Gaposchkin, S.	SG	1	13
Baldwin	Bl	68	173	Haas, W.	Ha	4	20
Ballhaussen	Ba	9	27	Halbach	Hk	67	123
Belsham	Bj	49	69	Hamilton	Hm	8	81
Benini	Be	10	13	Hartmann	Hf	82	154
Binney	Bf	1	1	Hassler	Hz	5	5
Blunck	Bu	3	8	Heines	Hh	7	9
Bouton	B	52	66	Hildom, A.	Hi	11	43
Bowie	Bi	1	1	Hildom, L.	Hl	5	6
Brady	By	12	17	Holt	Hb	8	18
Brown, S. C.	Bs	24	34	Houston	Hu	20	53
Brydon	B	1	5	Houghton	Ht	73	181
Buckstaff	Bc	9	18	Howells	Hj	1	1
Callum	Cl	7	11	Howes	Hv	9	30
Chandra	Ch	1	6	Iedema	Ie	23	28
Christman	Cm	34	49	Jacobs	Jb	1	13
Cilley	Cy	33	48	Jansen	Je	7	7
Dafter	Df	3	28	Jones	Jo	90	278
Dalton	Dt	1	7	Kanda	Kd	20	90
Diedrich	Dh	14	57	King	Kg	3	10
Doolittle	Dl	28	155	Kirkpatrick	Kp	10	31
Ellis	Es	6	6	de Kock	dK	10	35
Farnsworth	Fa	4	7	Koons	Kn	6	9
Focas	Fc	52	70	Lacchini	L	2	6

SUMMARY FOR FEBRUARY, 1935—Concluded

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Loepfe	Lf	3	5	Seely	Sa	1	4
Loreta	Lt	31	64	Shinkfield	Sl	16	23
Marchesini	Mh	1	20	Shultz	Sz	6	6
McLeod	Mc	21	39	Simpson A. M.	Sd	5	5
McKnelly	My	13	13	Simpson J. W.	Si	44	96
Millard	Md	15	17	Smith, F. P.	Sq	6	6
Monnig	Mg	8	9	Smith, F. W.	Sf	2	10
Newton	Nt	1	16	Smith, L.	Sh	2	2
Peck	Pb	60	141	Thomas	To	1	2
Peltier	Pt	168	240	Wade	Wh	6	6
Poole	Po	3	3	Walton	Wu	8	11
Popkavich	Pv	2	2	Watson, F.	Wf	1	3
Preucil	Pf	7	11	Watson, P.W.	Wa	16	55
Purdy	Pg	2	3	Webb	Wd	54	70
Raphael	Ra	23	48	Williamson,			
Reed	Rd	1	19	D. E.	Wm	4	5
Rosebrugh	Rb	20	75	Woods	Wp	12	28
de Roy	Ry	8	26				
Schofield	SL	1	12	Totals	87	379	3572

William Schofield, of Joliet, Illinois, Donald E. Williamson, of Carleton College, Northfield, Minnesota, M. W. Jacobs, Jr., of Harrisburg, Pennsylvania, Carlos A. Purdy, of Lodi, California, and the three observers of the Athens Observatory, Messrs. Plakidis, Focas, and Kotsakis.

The past few months have certainly been of great interest to variable star observers. First, there was the somewhat rapid drop, after a ten year period of maximum light, of R Coronae Borealis. This star, after dropping to twelfth magnitude with some fluctuations on the way down and rising again up to about ninth magnitude with very sudden changes in light as is typical of this star, has been quite well observed, especially considering its very unfavorable location in the sky. Then, in December, we had the appearance of the Nova in Hercules of which observations have been made by nearly four score A.A.V.S.O. observers and hardly a night has been missed since discovery. Then, too, late in December and early in January the famous Mira Ceta was at maximum, about magnitude two and a half. This is the brightest maximum for this star in nearly thirty years. Chi Cygni has also been favorably placed for observation and the still-stand, which frequently happens on the increasing side of the curve, was fairly well observed at about ninth magnitude, after which the variable rose steadily to the fifth magnitude.

Nova Herculis still continues to be of special interest, especially so since it can be observed in the eastern sky at about midnight. The Nova has remained at maximum brightness for an unusually long time, rivalled only in recent years by Nova Aurigae of 1891. In fact, the light curve of Nova Herculis so far very closely resembles the observed light curve of Nova Aurigae, not only in its rise to maximum but, in more recent weeks, in its rounding off, apparently preparatory to its more rapid decrease to minimum. Should this rapid decrease actually take place, it behooves all observers to be constantly on the watch to obtain observations at very frequent intervals. Incidentally, the Nova was discovered independently by three A.A.V.S.O. observers, Mr. L. C. Peltier, while roaming the wilds of Arkansas, by Mr. R. G. Chandra, of Bagchar, India, and by Miss Margaret Harwood, of Nantucket, Massachusetts.

In the report submitted under the date of February 11, 1935, describing the rise of SS Cygni during February, instead of the rise beginning on the second, as there stated, it began on the sixth, eight days later than the predicted date.

LEON CAMPBELL, Recorder.

March 9, 1935.

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

One of the encouraging things about the meteor work by our members in 1934 was the increasing attention paid to both photographic and telescopic meteors. Several unusual observations of telescopic meteors were made which will be briefly discussed.

An interesting radiant was secured by Stuart L. O'Byrne of Webster Groves, Missouri, on the night of 1933 December 10 at 8:33, while he was observing variables with his 2-inch telescope, power 33. He saw in the field a stationary yellow 4th magnitude meteor at (1900) $\alpha = 294° 36'$, $\delta = +49° 23'$, A.M.S. radiant number 2802. It lasted 0.3 seconds. Five minutes later, with the naked eye, a 2nd magnitude yellow meteor was seen, about 20° south of this position, whose projected path would fully confirm the radiant.

On 1934 August 11-12, L. E. Armfield at Milwaukee, Wisconsin, using a 10-inch telescope with 45′ field, was observing for the purpose of plotting telescopic Perseids. He used the A.A.V.S.O. chart of W Persei, and between 12:15 and 14:45 succeeded in plotting eleven meteors within an area about one-half degree square, just north of the variable. Their magnitudes, in order of appearance, were 11, 12, 13, 11, 11, 7, 10, 11, 10, 8, and 9. The meteors were scattered in directions, and no single radiant will fit them all. However, seven out of the eleven give a radiant at (1900) $\alpha = 41° 12'$, $\delta = +56° 32'$, A.M.S. No. 2803, all the paths coming within about 5′ of this position. Nos. 1 and 5 go at right angles to the average of this group and away from the radiant; they are possibly sporadic. Nos. 3 and 9, combined with No. 6 which already fits the above radiant, would give an extremely sharp radiant at $\alpha = 40° 45'$, $\delta = +56° 48'$. Nine of the eleven (all except Nos. 1 and 5) are almost certainly Perseids, and the short distance between the two positions, only 22′, probably indicates merely the actual size of the radiant area. In any case, we are sure that the Perseid radiant is not a point. Of these eleven meteors, only one, No. 7, of 10th magnitude, left a train; it remained visible for ten seconds, but did not shift its position during this time.

C. B. Ford at Ann Arbor, Michigan, on 1934 August 12-13, using a 1¼-inch finding telescope with 5°± field, between 11:45 and 12:38 plotted thirteen meteors near the Perseid radiant. The magnitudes of twelve were 7, 5, 7, 6, 6, 6, 7, 8, 7, 6, 9, and 7. He used a copy of the B.D. chart and finds a sharp radiant based on seven meteors at (1900) $\alpha = 43° 51'$, $\delta = +55° 17'$, A.M.S. No. 2804. Nos. 1 and 2 were sporadic; Nos. 3?, 4, 6, and 8 were probably Perseids but did not come closer than 1°.2 to the adopted radiant.

On the evening of 1934 December 3, J. Wesley Simpson, at Webster Groves, Missouri, was observing the variable X Ophiuchi, using the A.A.V.S.O. chart. At 6:33 he saw a white meteor of magnitude 8, with a path 19′ long which could be plotted on the chart. Within the next three minutes, three others appeared, of magnitudes 9, 9, and 10, all within an area about one-half degree square. All were plotted, and their projected paths give a very sharp radiant at (1900) $\alpha =$

278° 47′, $\delta = +8° 32'$, A.M.S. No. 2805. From the appearance of the plots, the radiant should be correct to 2′ or 3′. These four meteors were evidently closely connected, and most probably were parts of one larger mass in some manner broken into fragments.

No attempt is here made to discuss statistically the telescopic meteors reported for 1934. The data of many years must be combined if the results are to have any real meaning. We take this opportunity, however, again to ask A.A.V.S.O. and other observers, particularly those working with rather large fields of view, to keep a record of the telescopic meteors seen and to report them at the end of each year. The time so spent is negligible, and the results are of value. Instructions will be sent on application.

As stated in the annual report last month, nearly 300 fireballs were observed in 1934, in addition to a few major ones for which very large numbers of observations were received. These 300 were reported separately by individuals mostly from ships at sea but also by persons on land. A number of other fireballs are included in the reports of the A.M.S. members on nights of regular observing, and are not included in the above rough summary. We have carefully examined the recording cards for duplicates and have found fourteen. Much to our disappointment, for most fireballs for which there are only two observers, at least one leaves out some essential datum, so that height computations are impossible. With the hope that some reader may have a further observation on these doubly-observed objects, the following table is presented.

1934	Time	Location of Observers	No. of Obs.	Mag.
April 6	10:33 GMT	$\lambda = 87°$ W, $\phi = +27°$	2	3 × Venus
May 20	8:44 EST	SE Cape Charles, Va.	3	⅔ Moon
June 1	15:19 EST	Pennsylvania	2	= Jupiter
June 7	8:40 EST	$\lambda = 82°$ W, $\phi = +24°$	2	V. bright
Aug. 30	9:38 EST	New York, New Jersey	2	= Venus
Aug. 31	7:38 EST	Maine	2	¼ Moon
Sept. 13	13:07 EST	South Carolina	2	>Moon
Oct. 1	8:15 EST	North Carolina, Virginia	2	>Venus
Oct. 7	11:41 EST	Pennsylvania	2	0^M
Oct. 9	2:13 GMT	$\lambda = 75°$ W, $\phi = +21°$	2	Bril; 20^M train
Nov. 5	9:10 EST	New Jersey, Pennsylvania	2	= Venus
Nov. 7	9:40 EST	New Jersey, Pennsylvania	2	?
Nov. 9	8:45 EST	New York, Connecticut	2	3 × Venus
Dec. 3	13:55 CST	Arkansas	4	>Moon

Only the fireball of May 20 was sufficiently completely reported so that heights and other results could be computed; yet eleven of the others were seen over thickly settled parts of the United States, and most of them appeared in the earlier hours of the night. This proves that despite the remarkable growth of interest in meteoric astronomy, a tremendous lot of effective advertising remains to be done; for there is no doubt that every one of these objects was seen by many intelligent people capable of making useful reports if only they would take the trouble, or perhaps if they knew that reports were desired and where to send them. We hope that the publication of this note may do good in calling further attention to the subject, even if it fails to elicit more information on the specific objects listed.

For 1934, the number of reported fireballs leaving trains that endured over one minute was very small. If persons realized how very important are observations on train-drifts (both in direction and in angular velocity), opportunities for reporting such rare data would not be wasted. The drifts furnish us with our only accurate means of determining wind velocities in the upper atmosphere. We

urge everyone fortunate enough to see such a train to make the fullest notes possible upon its appearance and drift, preferably with a sketch showing the successive shapes and positions.

The following table of radiants was derived by R. A. McIntosh from his 1934 observations in Auckland, New Zealand.

A.M.S. No.	Date 1934	R.A. °	Dec. °	No. of Meteors	Wt.	Remarks
2806	Mar. 25.67	272.5	—27.5	4	Good	
2807	June 13.68	307.5	—18.0	5	Good	
2808	June 13.68	326.5	—29.5	5	Good	
2809	June 15.66	290.0	—14.5	6	Good	See 2812
2810	June 15.66	333.5	— 7.5	1	Good	Sta. met.
2811	June 22.68	11.7	—11.3	1	Good	Sta. met.
2812	June 22.68	296.0	—11.0	6	Good	See 2809
2813	July 17-18c	14.0	—20.5	5-6	Good	
2814	Aug. 6.70	347.5	—11.5	3-4	Good	δ Aquar.
2815	Sep. 6.66	19.0	— 5.5	3-4	Good	
2816	Sep. 6.66	30.0	—19.0	3-4	Good	
2817	Dec. 6.63	100.0	—44.5	7	Good	See 2669

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1935 March 8.

The Meteor of July 25, 1929

By C. C. WYLIE

(Second Paper)

One of the most brilliant meteors of recent years fell over the state of Illinois at 9:46 P.M., 90th meridian time, July 25, 1929. It lighted up nearly a million square miles of territory, and several hundred letters were received. A preliminary paper was published in POPULAR ASTRONOMY, **37**, 514-519, 1929. This paper gave the path through the atmosphere as determined by the interview method of the *Midwest Meteor Association*. It included also some typical impressions, and a discussion of the errors appearing most often in the numerous letters received. Another paper on the meteor appeared in POPULAR ASTRONOMY, **39**, 521-524, 1931. This gave the path through the atmosphere as determined from letters received by the *American Meteor Society*. A further note from the *American Meteor Society* appeared under "Meteor Notes" in the June-July, 1934, issue of POPULAR ASTRONOMY.

Because of the large number of observers, an unusually high selection was possible for the interviews. No other meteor has furnished as much material on the difference between the reports received by letter and the results attained by interviews. The material has, therefore, as our methods of computing have developed, been worked over by five different computers since the publication of our first article. No significant change was made at any time in the position or height of the end point, or in the radiant, but the point of appearance and the velocity have been changed considerably. This paper is, however, a presentation of results obtained by new methods in meteor work, rather than of results on the single meteor.

The first step in the study of the meteor was the selection of observers for interview, from the hundreds of letters received. The method followed was, in general, that described in "A Classification of Fireball Data" in POPULAR ASTRONOMY, January, 1935. It was possible to restrict the interviews almost entirely to

persons who saw the meteor while sitting in their own homes or yards. Because of a thunderstorm in Illinois, few useful reports could be obtained from the district where the meteor actually burst. But the weather was clear along the Mississippi river, and people sitting in their yards on the Iowa side of the river had an excellent view of the meteor over Illinois. Letters showed it was also clear in Chicago, on the other side of the meteor, but the smoke and dust of a great city interfered, and the horizon in the residence district is probably five to fifteen degrees high. We did not, therefore, go into Chicago for interviews, but we did have an observation made in Chicago by a university professor of engineering.

The End Point

For the final determination of the end point of this meteor, the observations used fall into three classes:

1. Observations made directly by astronomers and college professors of science or engineering.
2. Observers interviewed by the writer.
3. Observers interviewed by a college professor of astronomy, or by an engineer.

At Williams Bay, Wisconsin, Stebbins and Morgan, both trained astronomers, independently estimated the right ascension and declination of the end point of the meteor a few minutes after it fell. The estimate was made from stars in that region of the sky. The writer visited Williams Bay soon after the fall of the meteor, and interviewed these men, as well as the other astronomers who saw the meteor. They, however, made no estimate of its position. At Iowa City, Iowa, the writer made measurements on the path as seen by nine different observers, with each standing at the point where the meteor was observed. The first observer was interviewed less than ten minutes after the fall of the meteor. The writer also recorded interviews at Clinton, Bettendorf, and Muscatine in Iowa, and at Sterling and Sycamore in Illinois. At Dubuque, Iowa, Father J. A. Theobald of Columbia College, interviewed five observers, and at Bettendorf, Iowa, Mr. J. Hansen, an engineer and amateur astronomer who was interviewed by the writer, himself interviewed three other observers. The Chicago report is the observation of Professor E. B. Paine, of the College of Engineering of the University of Illinois. The writer also visited, but recorded no interviews, in De Kalb, Aurora, Geneva, and Crystal Lake, in Illinois, and Beloit in Wisconsin.

For each community a weighted mean of the observations was formed. Taking the number of observations, distance from the end point, and other facts into consideration, the adopted path for each community was weighted as follows:

Williams Bay	infinity	Sterling	1
Dubuque	3	Muscatine	1
Clinton	2	Sycamore	1
Iowa City	2	Chicago	1
Bettendorf	2		

A map showing longitude and latitude in stereographic projection was prepared, with the pole at the estimated end point. This meant that any great circle, such as an azimuth line, through the end point would project into a straight line on the map. The longitude and latitude of the projection of the end point were determined graphically, with the result—*Longitude* 88° 33′1, *Latitude* 41° 54′2. This is a point about ten miles east and one mile south of De Kalb, Illinois. The residuals in miles for the various communities are as follows:

Williams Bay	0.0	Iowa City	6.2 S
Bettendorf	2.0 S	Sterling	6.2 S
Chicago	2.5 S	Muscatine	7.0 N
Dubuque	2.8 N	Sycamore	3.4 N
Clinton	4.7 N		

The letter S means that the azimuth line goes south of the adopted end point, and N means that it goes north of the adopted end point. The probable error of the end point in a north and south line, computed from the weights and residuals by the usual formula is ±1.13 miles. It should be noted that the residuals, and the probable error, include all observations which a computer following our routine instructions would select for use. The height at bursting was found to be 25.8 miles. When a meteor bursts like a sky rocket, the bursting point is usually the only well-defined terminal point. For this meteor we can consider "bursting point" and "end point" as synonymous.

As a check on the adopted end point, we have three observations worthy of confidence. The first is from Hinsdale, where the meteor was seen through a window and the direction was, therefore, fixed much better than is the case for an observer out of doors. The residual for this observation is 11.0 N. The second is from Morrison, where a lady, at the request of a local high-school teacher, reported that she had seen the meteor end due east. The residual for Morrison is 6.5 S. The third is from Toulon, where a lady measured her own observation and sent us the results. The residual for Toulon is 13.0 S.

It will be noted that counting both the fundamental and check observations, we have reports from four communities within 50 miles of the end point; the closest observation, from near Sycamore, being only 12 miles from the end point.

An unusual newspaper error gave an additional check on the approximate accuracy of the adopted end point. Two days after the fall of the meteor, a story was given to the press stating that the meteor ended a few miles north and west of *Aurora, Illinois.* In a few newspapers the word Aurora became *Peoria,* presumably through dictation or a telephone conversation on account of the similarity of sound of the two words. This error brought in a half-dozen letters from persons who had observed the meteor from their own homes and had the direction of ending well fixed. Each of these letters stated that the writer had had a good view of the meteor, and that the end point must have been many miles farther north than Peoria. These letters all checked the adopted end point satisfactorily. The correct version of the story, giving the end point northwest of Aurora, was much more widely printed, but not a single letter questioning this ending for the meteor, was received from an observer.*

Aside from letters from the general public, four reports were received which appeared discordant with the adopted end point. These indicated endings for the meteor from more than fifty miles south of the adopted end point to more than fifty miles north of the same. All had already been discarded for other reasons than discordance in azimuth, but they were investigated more fully. For the first report the discordance was quickly corrected by a second letter which stated that the first letter gave merely a guess on the direction of the meteor. The measurements enclosed with the second letter agreed with other observers in the same community. The second report was an interview with a lady living in a Mississippi-river city, with a good view of the meteor but with a very uniform horizon. Her path was discordant in altitude and length, as well as in azimuth,

*Professor C. P. Olivier sent us a letter in which he stated that our end point was too far south.

and was contradicted by neighbors living only a block away who did not know the path she had pointed out. They had seen the meteor burst and disappear through a small opening between two buildings, and were positive that all of the sparks had disappeared before reaching the northern limit of the opening. This meant that the meteor had disappeared at a point about forty degrees south of the end point indicated by the lady with the uniform horizon. The third discordant report was received from a trained man who interviewed an observer more than a month after the falling of the meteor, but not at the point of observation. He did not believe it worthwhile to drive to the point of observation after that interval of time. The path pointed out was much too long, extending from beyond the radiant south to twenty-six miles north of the adopted end point. The path was also too high, so the discordance was not taken seriously. The fourth report was received from a trained observer, but he stated the figures were estimates from memory rather than real measures. It appeared that both beginning and ending of the path were shifted in azimuth.

Few letters from the general public gave any definite azimuths, but there were many reports which at first seemed discordant. An investigation was made in every case where it was thought the letter justified it. The result was that not a single report remained which any of the computers considered a real disagreement with the adopted end point.

The Radiant

For determining the radiant, a measurement of the point where the meteor was first seen is needed, as well as a measurement of the end point. In other words, it is essential that the slope of the path be reasonably well determined. For this, the observations selected and the weights assigned were as follows: Williams Bay, 5; Iowa City, 3; Dubuque, 2; Decatur, 1. No interviews were made in Decatur, and so we are departing from our usual custom in using the Decatur reports. However, the letters indicated that, of the cities with clear weather, Decatur was the one where the meteor was seen to fall the nearest to vertically downwards. It was not convenient for us to visit the community in person, so we requested a number of people who wrote from Decatur, to draw an angle showing the departure from vertical in the fall of the meteor.

Using the adopted end point, the altitude and azimuth were calculated as they should have been seen from each of the above communities. These calculated positions were then all reduced to altitude and azimuth with the zenith of the adopted end point. Using a large stereographic projection centered on the zenith, the observed apparent path of the meteor was drawn for each of the above communities. Then, through the computed end point, a great circle was drawn parallel to the observed path and projected back toward the radiant. These paths projecting back intersected in a small area. The adopted radiant is *azimuth* 352° 6′ west of south, *altitude* 33° 6′ with a probable error of about ±0°.1. These are the altitude and azimuth of the radiant as seen by an observer at the projection of the adopted end point.

Using the adopted end point and radiant, the ground point was solved for, and also the altitude and azimuth of the radiant as seen from the ground point. The ground point was found to be *longitude* 88° 40′, *latitude* 42° 28′. The uncorrected radiant is *azimuth* 352° 2′, *altitude* 32° 32′. These are the altitude and azimuth of the radiant as seen from the ground point.

Using the velocity (determined later), the radiant was corrected for zenith attraction giving *azimuth* 352° 2′ west of south, *altitude* 16° 1′.4. The corrected

radiant was then reduced to right ascension and declination, giving *right ascension* $18^h\ 33^m3$, *declination* $-31°\ 9'$.

The Point of Appearance

The point where the meteor was first seen varies for different observers depending on whether they happened to be looking in that general direction, and also on the amount of light in the neighborhood. However, for people who were out doors away from lights and not looking up at the time, the point where it was first noticed is about the same. The agreement for communities as widely separated as Williams Bay, Dubuque, Bettendorf, and Iowa City is about as good as for the end point. Let us call this point, where the landscape becomes illuminated brightly enough to cause people to look up, the point of *illumination*. The adopted point of illumination is *longitude* 88° 29′, *latitude* 41° 30′. The residuals in miles for the communities previously mentioned are:

Williams Bay	2 S	Bettendorf	0
Iowa City	2 S	Dubuque	4 N

The letter S means, as for the end point, that the azimuth line passes south of the adopted point, and the letter N means that it passes north. The height of the path at this point is 44.7 miles. The real length of path from illumination to bursting is 34.6 miles, and the projected length is 28.2 miles.

We interviewed only one observer with good landmarks who happened to be looking at that part of the sky when the meteor first appeared. This was Mr. Lloyd O. Ritland, a graduate student at the University of Iowa, who was going up a flight of outdoor steps, and happened to be looking up in the right direction just as the meteor appeared. He stated that when he first saw the meteor, it was merely a bright shooting star. Probably, however, it was brighter, as Mr. Ritland was on the University of Iowa campus which is well lighted. Mr. Ritland's observation indicates that he first saw the meteor over a point in *longitude* 88° 19′, *latitude* 40° 35′, and at an altitude of 89 miles. Let us call this point on the path, *first seen*. The real length of path from *first seen* to bursting is 113.4 miles, and the projected length is 93 miles.

The Velocity

For determining the velocity of the meteor we need, in addition to the distance traveled, the duration. We gave greatest weight to the estimate of Professor Joel Stebbins, who saw the meteor from Williams Bay, Wisconsin. Professor Stebbins has an excellent sense of time, being able to count seconds for short intervals in almost perfect agreement with a stop-watch. His estimate of duration, recorded immediately after the fall of the meteor, was "five or six" seconds. This estimate is for the duration from illumination to bursting. Another reliable value for the duration was obtained from Mr. John Hansen of Bettendorf. Mr. Hansen is the only person we have ever interviewed who counted during the flight of a brilliant meteor. Mr. Hansen repeated this count while we held a stop-watch, giving five seconds as his value for the duration. This also refers to the duration from illumination to bursting. For a considerable number of other observers where there was reasonably definite action during the flight of the meteor, we had the scene re-enacted as nearly as possible while we held a stop-watch. In this way we obtained several additional values for the duration of the meteor. The following were used to determine the duration from illumination,

Stebbins	5.5 seconds, weight 5	Iowa City	1.5 seconds, weight 3
Hansen	5 seconds, weight 4	Dubuque	3 seconds, weight 3

The weighted mean of the above observations gives for the velocity of the meteor

8.51 miles per second in the earth's atmosphere, with a probable error of ±2.7 miles per second.

From the apparent velocity 8.51, we find the true geocentric velocity to be 4.95 miles per second. The geocentric velocity (not the apparent velocity) was reduced to heliocentric by the usual formulas giving 21.5 miles per second. This is definitely an elliptical velocity, and the meteor was therefore, before its fall, a member of our solar system.

Detonations

In investigating detonations our procedure is to first make inquiry in the district where appreciable detonations would have been noticed by everyone out doors in reasonably quiet surroundings. If no one heard possible detonations in this district, it is assumed that further inquiry is not needed. For this meteor, in our interviews, we failed to find anyone any where who had heard noises which either he or we really thought came from the meteor. Because of the thunderstorm, of course, several reports of thunder soon after the fall of the meteor were received. These reports, however, in so far as thy came to our attention were all outside the area where detonations should have been heard.*

Effect of Curvature of Earth

A comparison of the impressions of observers at different distances from the end point is interesting. As the meteor burst at a height of about 25 miles, the nearer observers assumed it was consumed in the air.

At distances of more than 100 miles, many who saw the meteor apparently drop behind some tree, or other object, made a search the next day. Five supposed findings of the meteor were reported to us.

At a distance of 350 miles a lady saw, "What looked like a shooting star, only behind it there was a stream of light. As it hit earth (it looked like it) there was a lighting up as if there was an explosion, but we heard no noise." At that distance, the meteor burst only about one degree above the true horizon. It would have burst below an average good natural horizon in the country.

Farther away, the meteor was glimpsed momentarily before it went below the horizon, and farther away still only the illumination was seen. At a distance of about 520 miles an observer saw, "A very brilliant pale green light of about five seconds duration appearing just a little south of due east from O'Neill and low on the horizon. . . . I was startled by this remarkably brilliant glow. . . . I saw no ball of fire nor tail." At that distance, the point of illumination was less than one degree above the true horizon. Even allowing for refraction, an observer would have needed an almost perfect horizon to glimpse the meteor.

Stopping Power of the Atmosphere

Observations of bright meteors such as this show that for objects at high velocity the stopping power of the lower atmosphere must be exceedingly great. Just before bursting, this meteor lighted up several states with an illumination at least equal to that of the full moon. One of the first observers we interviewed suggested that we wait until daylight so that the buildings marking the end point could be seen as they were in the light of the meteor. The meteor disappeared in open sky, where stars were visible, for residents of Iowa City. No fragment giving as much light as a bright shooting star could have continued after disappearance. We interviewed people in various communities who saw the meteor disappear

*Some of these distant reports were accepted by others as detonations. See "Meteor Notes" in the June-July, 1934, issue of Popular Astronomy.

in a rather small area of sky between two buildings or between two trees. These persons were sure that no sparks continued as far as the northern edge of the small area. This showed that the complete disappearance after bursting was very quick. We also interviewed many people who on seeing the bright meteor, had called to another person to look. Sometimes, on turning his head, the other person had seen the meteor before it burst. Sometimes he missed the meteor itself but glimpsed the trail momentarily. Sometimes, especially if he had to move, he did not see even the trail. In no case did he miss the meteor itself but see the sparks after it burst. This again showed that the sparks must have continued for an exceedingly short time.

The agreement of the end point, for different communities varying from very close to the path of the meteor to more than 100 miles away, shows that the point of disappearance was practically the same for all communities. Indeed the agreement between the average paths for different communities is much better than the agreement between individual paths in the same community.

From theoretical considerations it is evident that a mass the size of an ordinary shooting star would survive for only a very short distance in the lower atmosphere. Even a reasonably bright shooting star is usually consumed before it reaches an altitude as low as 50 miles. In dropping from infinity to 50 miles it has encountered an air mass sufficient to consume it. At the height at which this meteor burst, it would encounter the same air mass in dropping less than half a mile. At the angle at which this meteor was falling, the horizontal distance traveled would have been about three-fourths of a mile.

If we assume that an average shooting star is consumed at a height of 62 miles, the air mass encountered is only 1/600,000 that which it would encounter in dropping to the ground. This exceedingly small air mass is one reason why physicists obtain very small masses for shooting stars.

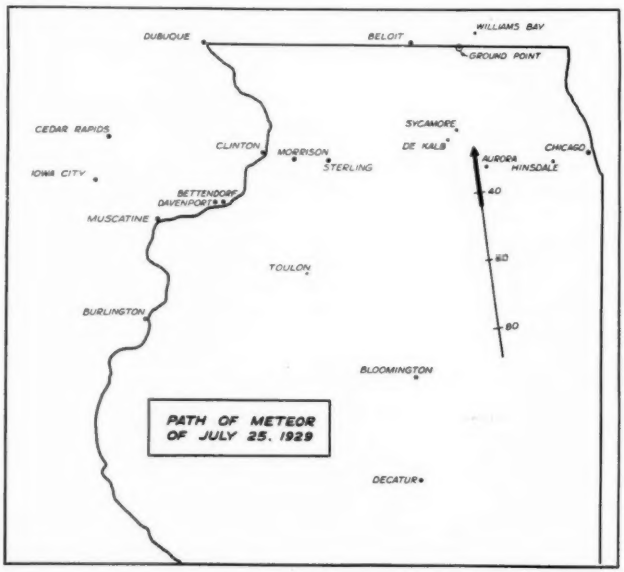
Comparison with Earlier Results

All computers gave the observations at Williams Bay heavy weight. The meteor was, for these astronomers, almost a stationary meteor, and very nearly due south. The longitude of the path and of the radiant are therefore nearly the same for all. The latitudes for appearance and disappearance are, however, fixed by other observations. A glance at the results shows that careful selection shortens the path. This is emphasized by including a "path" from press accounts of towns "passed over" by the meteor, and of where the meteor fell. These accounts would indicate that the meteor started over northeastern Arkansas, passed north across Missouri and Illinois into Wisconsin, and ended by falling into Lake Michigan near Milwaukee, Wisconsin. The projected length is more than 400 miles. The long paths reported without real calculation in older books were doubtless obtained in this way. Let us take next the path from letters, Popular Astronomy, **39**, 521-524, 1931. The projected length of this path is 194.4 miles. Let us take next the preliminary path from interviews which appeared in Popular Astronomy, **37**, 514-519, 1929. The projected length of path is 169.3 miles. Finally, let us take the path from this paper. We found that, for the vast majority of observers, the visible path was that from illumination to bursting. The projected length is 28.2 miles.

We have found that three effects tend to make published paths too long. The first is a tendency of observers to systematically over-estimate the length of path seen. This effect has been found in almost every case where an estimate has been checked against a measure with good landmarks. As a typical illustration, an in-

telligent man reported a bright meteor in May, 1934, which seemed for him to fall between two tall trees. He estimated the length of path seen as 20° and stated that he was reasonably familiar with angles. The trees made good landmarks for measuring the length of path really seen, and it was found to be 5°.

The second effect contributing to this lengthening of paths is a misinterpretation by observers of instructions received, or a misinterpretation by computers of information received by letter. It seems to be almost impossible to write instructions so that the general public will send what is wanted on the fall of a meteor. We have had this difficulty ourselves, and we have helped persons who were having difficulty with questions from the American Meteor Society. One of the most pronounced difficulties is due to the fact that a considerable number of persons seem to remember very little about the meteor excepting their im-

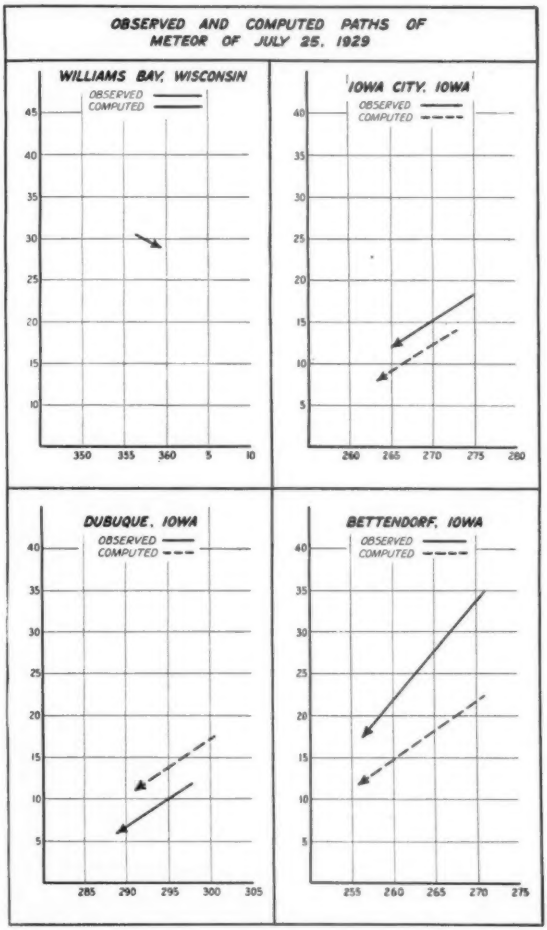


pression of the real direction of travel. For example, if a Chicago resident in a rather unfamiliar location sees a meteor moving in a northerly direction in the southwestern sky, his impression may be that the meteor is just over a building about a block away, and traveling in a northwesterly direction. On the next day, if questioned about it, he will report that he saw the meteor passing over Chicago and going northwest. Excepting by personal interview it is very hard to get anything out of such an observer other than his erroneous impression that it must have passed northwest of his part of the city. When the questions are answered without our knowledge by a friend familiar with angles, but who has not seen the meteor, matters are only made worse.

A third effect which lengthens the paths is the tendency of computers to assume that persons reporting the shorter paths saw less of the path than others. For bright fireballs this assumption is, as we have shown, not safe. Where people are outdoors and away from lights, interviews show that practically the same

length of path is seen over thousands of square miles. Where observers report distinctly different paths, the safe course is to interview these persons and remove or explain the discordance.

Comparing now the velocities, we find that the paper in POPULAR ASTRONOMY, **39**, 521-524, 1931, gives two figures, 45 miles per second and 32 miles per second. Little significance was, however, attached to either of these figures. Taking next



the paper in POPULAR ASTRONOMY, **37**, 514-519, 1929, we find two preliminary figures given. These are 50 miles per second and 30 miles per second. In this our final paper by a shortening of the path and a careful selection of estimates of duration, the value for the apparent velocity has been reduced to 8.5 miles per second. This is indeed a surprising reduction, and it brings the heliocentric

velocity well under the limit for elliptical orbits. This value of the velocity was obtained only because an exceptional selection of observational material was possible. It causes one to question practically all hyperbolic velocities which have been published for fireballs.

On the accompanying map we have plotted the projected path of the meteor, with the portion after illumination drawn heavier. We have also plotted the observed and computed paths for Williams Bay, Iowa City, Dubuque, and Bettendorf. These show that, as would be expected, the azimuths from our interviews are better than our altitudes.

The computers who have worked on this meteor are, in order, I. F. Keeler, R. E. Crilley, M. P. Roller, B. Boyd, and L. R. Wylie. This work has been supported in part by the Graduate College of the University of Iowa, and in part by a grant from the J. Lawrence Smith fund of the National Academy of Sciences.

Comparison of Results

The following presents in tabular form the three sets of results on this meteor to which we have referred. The first set is the path from letters received by the American Meteor Society. The second is our own preliminary path. The third is our final path from interviews. In our final path we are using for point of appearance the point of illumination, since that was the point of appearance for the vast majority of observers, and is the point which must be used in determining the velocity.

	Letters	Preliminary Interviews	Final Interviews
Longitude end point	88° 31′	88° 27′	88° 33′.1
Latitude end point	42° 24′	42° 1′	41° 54′.2 ± 1′.0
Height end point	6.9 miles	24 miles	25.8 miles
Longitude appearance	88° 11′	88° 19′	88° 29′
Latitude appearance	39° 35′	39° 36′	41° 30′
Height appearance	138 miles	118 miles	44.7 miles
Length path	235 miles	193.5 miles	34.6 miles
Projected length	194 miles	169 miles	28.2 miles
Apparent velocity	32-45 miles	30-50 miles	8.5 mi. ± 2.7 mi.
Heliocentric velocity			21.4 miles
Altitude radiant	32°.6		33°.1
Azimuth radiant	354°.9		352°.1 ± 0°.1
Altitude corrected radiant	27°.4		16°.0
Azimuth corrected radiant	354°.9		352°.0
R. A. corrected radiant	276°.4		278°.3
Decl. corrected radiant	—20°.2		—31°.1

University of Iowa, March 19, 1935.

Meteors Observed

At 9:13 P.M. on Friday, February 15, a meteor started 3° west of Polaris and for 4 seconds was visible as it fell perpendicularly toward the horizon. The moon was 12 days old and yet the meteor was easily seen as it travelled behind a haze of clouds. It was a beautiful phenomenon. (Observation by Mr. Estil Meadows, communicated by Professor W. R. Hutcherson, Berea College, Berea, Ky.)

A bright meteor was observed from Allentown, Pennsylvania, in the early evening of February 27, in the region of the sky near the planet Venus. The trail of smoke slowly changed its configuration and remained visible for approximately five minutes. (Observation by William A. Reimert, communicated by Dr. D. George Knecht, Allentown, Pa.)

While sitting in the living room looking out of the window, I saw what ap-

peared to be a shooting star. But contrary to a shooting star it traveled in a zigzag line. Then it seemed to stop suddenly, leaving a yellow, zigzag line. This line gradually grew dim, and at the end of ten minutes disappeared. The time of this observation was on February 27, 1935, at 5:20 P.M. The vision appeared in the west. There were very few stars in the sky at this time, and the sun had just set.

EDWARD MAYKUT.

Collegeville, Pennsylvania, February 28, 1935.

Contributions from the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD, President, and H. H. NININGER, Secretary

Bibliography of Meteoritics: First 1935 List

Compiled by FREDERICK C. LEONARD *and* ROBERT W. WEBB

[Continued from the Fourth 1934 List in *N.S.R.M., P.A.*, **42**, 600-2, 1934. *Anonymous* and *initialed* articles are enumerated under the *periodicals* in which they appeared. The serial numbers commence with 1 in this list, since it is the first compilation of the year.]

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List of New Members of the Society

[Contributed from the list in the *N.S.R.M., P.A.*, **42**, 344-5, June-July, 1934.]

Mr. W. F. Bingham, Civil Engineer, U. S. Reclamation Bureau, Ear, Calif.
Mr. John Davis Buddhue, 99 S. Raymond Ave., Pasadena, Calif.
Mr. Ernest W. Chapman, 1814 Pepper St., Alhambra, Calif.
Mr. F. G. Fales, 21st Floor, 67 Wall St., New York, N. Y.
Mr. Douglas K. Fischer, 9105 Bryden Ave., Detroit, Mich.
Dr. Clyde Fisher, Curator, Dept. of Astronomy, American Museum of Natural History, New York, N. Y.
Mr. Don Grafflin, Associate, Boys' Work, Y.M.C.A., Greenwich, Conn.
Dr. L. H. Hayden, Optometrist, 320 Ricou-Brewster Bldg., Shreveport, La.
Mr. J. A. Hess, Pedro Miguel, *Canal Zone, Panama, Central America.*
Mr. Richard T. Hosking, Jr., A.T.M.S., Chicago, 312 Armory Ave., Champaign, Ill.
Prof. Harry Hutter, Dept. of Geography, Northern State Teachers College, Aberdeen, S. Dak.
Prof. J. H. Jensen, Head, Division of Science, Northern State Teachers College, Aberdeen, S. Dak.
Dr. Joseph Kaplan, Dept. of Physics and Dept. of Astronomy, University of California at Los Angeles, Los Angeles, Calif.
Mr. Alfred Knight, 16 Beechmont Ave., Cedar Knolls, Bronxville, N. Y.
Mr. Oscar Lindquist, 114 S. West St., Marengo, Ill.
Mr. E. H. Luschi, Oelrichs Public Schools, Oelrichs, S. Dak.
Dr. Kirtley F. Mather, Geological Museum, Harvard University, Cambridge, Mass.
Mr. D. Molyneaux, 22 Murray St., Binghamton, N. Y.
Mr. Walter Randall Redmond, Principal, Greenwood Union School, Greenwood, N. Y.
Dr. Wilbur Irving Robinson, Dept. of Geology, Texas Technological College, Lubbock, Texas.
Mr. A. D. Shepersky, Instructor in General Science, Huron High School, Huron, S. Dak.
Dr. Merrill A. Stainbrook, Dept. of Geology, Texas Technological College, Lubbock, Texas.
Mr. R. W. Stone, Assist. State Geologist, Dept. of Internal Affairs, Harrisburg, Pa.
Mr. Charles Stuart Street, 240 E. 51st St., New York, N. Y.
Dr. Ralph Sylvester Underwood, Dept. of Mathematics, Texas Technological College, Lubbock, Texas.
Miss Margaret C. Walker, Assist. Prof. of Geography, Mills College, and Chabot Observatory, Oakland, Calif.
Mr. Clarence J. Wheeler, Jr., 2627 Park Row, Dallas, Texas.

The Society has of date 1935 February 13, 106 members. Since its inception, it has lost two by death, Dr. Oliver C. Farrington, the *Honorary President*, and Dr. Gavin J. Burns (of London, England). Two others, Mrs. Anne Atwood King and Mr. Remley Herr, have dropped their memberships.

Secretary's Office: The Nininger Laboratory, 1955 Fairfax Street, Denver, Colorado.

Editorial Office: The Department of Astronomy of the University of California at Los Angeles.

Zodiacal Light Notes

By FRANKLIN W. SMITH

The evening Zodiacal Light was observed between 7:30 and 7:40 E.S.T. on February 26. The northern edge pased through points a degree or two south of γ Pegasi and a similar distance south of γ Arietis, and south of the Pleiades. The southern edge passed through ξ_2 Ceti and μ Ceti. The eastern extremity of the

light cone could not be distinguished very far beyond the Pleiades because it blended with the Milky Way in the eastern part of Taurus. The observation suffices, however, to show that the light cone could be traced to an elongation of at least 88° from the sun, and that its axis lay in or near the ecliptic. The apparent diameter of the cone near its base was about 18°.

The Gegenschein was observed on March 8 at 11:00 E.S.T. It was then in the eastern part of Leo within the region roughly bounded by χ, σ, and υ Leonis and ν and β Virginis. It was elliptical in shape with a major axis (extending along the ecliptic) of about 15° and a minor axis of about 10°.

407 Scott Ave., Glenolden, Pennsylvania, March 17, 1935.

Comet Notes

By G. VAN BIESBROECK

It has been a long time since we have had a comet as well in reach as 1925 *a* (JOHNSON). Its high declination has made it visible through the whole night and it has been bright enough for moderate instruments. The observations have been fairly numerous and most observers have characterized the object as diffuse without nucleus, the coma having a diameter of about 2′. The estimations of brightness are necessarily uncertain on an object of this kind. At the end of February when the maximum brightness was attained some observers called the magnitude 10 while others, including the writer, made it 8.5. This was obtained by visual extrafocal comparison with neighboring stars, the eyepiece being moved out of focus so much that the star's image is spread out in a circle about as large as the comet. Thus the integrated light of the latter is obtained and this is of course brighter than the focal estimation which refers mostly to the central part.

Not until February 27 was the sky favorable at the Yerkes Observatory for an exposure of a certain length on a moonless sky. The result is illustrated here and brings out the expected existence of a tail. The spherical coma diffuses out to a diameter of about 2′.8. In position angle 60° almost exactly opposite to the direction of the sun there appears a threadlike emanation which gradually spreads into a diffuse tail, traces of which can be seen as far as 35′ from the head on the original plate. This was only half a day after perihelion when the distance from the sun was reduced to 0.81 astronomical units. The record on the following nights is very incomplete on account of the weather conditions here but it does not seem that the comet has developed much activity. The tail was fainter on February 28, had less extension, and was more diffuse. On March 2 there was apparently a new slender threadlike emission but its length was only 4′. Moonless sky is awaited to investigate further developments.

Computers have been active in working out improved orbits and this has confirmed A. D. Maxwell's remark that there was already an appreciable deviation from a parabolic orbit. Although the orbit given by him (p. 188) proved to be the most accurate one published at the time, the same computer has refined his computation by including the measures up to March 9. The new result is as follows:

$$
\begin{aligned}
T &= 1935\ \text{Feb.}\ 26.46962\ \text{U.T.} \\
\omega &= 18^\circ\ 23'\ 19''.8 \\
\Omega &= 91\ \ 32\ \ 54.7 \quad 1935 \\
i &= 65\ \ 25\ \ 16.5 \\
q &= 0.8111197 \\
e &= 0.9912746\ (P = 896\ \text{years})
\end{aligned}
$$

with the improved ephemeris:

1935 0^h U.T.		α h m s	δ ° ′	—Distance from— Earth	Sun	Mag.
April	4	0 25 53	+62 29.1	1.176	1.056	10.4
	12	0 04 22	68 12.6			
	20	23 30 41	73 28.0	1.273	1.252	11.4
	28	22 29 43	78 02.6			
May	6	20 33 42	80 54.4	1.360	1.462	12.1
	14	18 05 24	80 12.5			
	22	16 30 53	76 21.3	1.459	1.676	12.8
	30	15 44 43	71 09.7			
June	7	15 21 36	65 31.2	1.594	1.890	13.6
	15	15 09 45	59 48.3			
	23	15 04 04	54 13.2	1.779	2.101	14.3
July	1	15 02 08	+48 52.6			

The change from the previous orbit is small and the elliptic elements are now probably quite well established except the period which cannot be determined more closely until the observations cover a long interval. M. Davidson found a

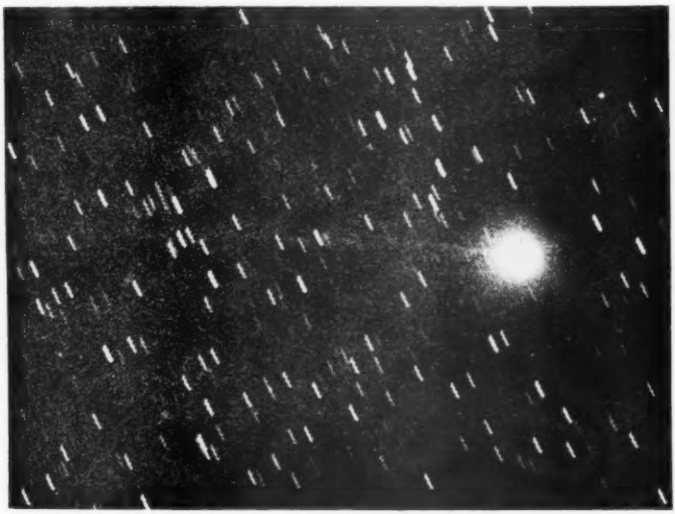


FIGURE 1.

COMET JOHNSON, 1935 FEBRUARY 27.
(Enlarged 2.5 times from a 20-min. exposure with the 24-inch reflector of Yerkes Observatory.)

period of nearly seven centuries from observations to February 21. The present period of nine centuries is probably more nearly correct and shows that in its long orbit this comet moves out about three times as far as the planet Neptune.

Figure 2 illustrates the relation of the comet's orbit to that of the earth. It shows the comet in the southern hemisphere at the time of the discovery on January 7, also how its distance from the earth as well as from the sun is now increasing so that it is bound to fade rapidly from now on. In the column magni-

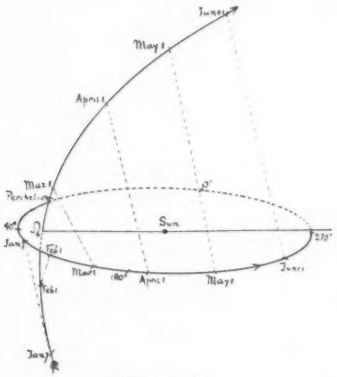


FIGURE 2.

ORBIT OF COMET 1935 *a* (JOHNSON) IN RELATION TO ORBIT OF THE EARTH.

tude that I have added to Maxwell's ephemeris the brightness has been assumed to vary as the fourth power of the heliocentric distance. In the beginning of April the comet is in Cassiopeia; its northerly motion will soon carry it into Cepheus and by May 10 the orbit passes within 9° of the north celestial pole. The decrease in brightness will soon limit the visibility to the larger instruments.

Three faint periodic comets can be followed with powerful instruments: PERIODIC COMET 1929 I (SCHWASSMANN-WACHMANN) was recorded here last on February 27 as a small nebulosity of magnitude 15.5 which showed a little tail about 2′ in length, a rather unexpected feature for so faint an object. It will soon be lost in the evening sky and will not reappear until next fall after the perihelion passage August 28.

PERIODIC COMET 1928 I (REINMUTH) was estimated as 15^{M} at the end of February when it also showed a tail on the following side about 1′.5 long. It is well placed in Gemini and may brighten up a little while it approaches perihelion on May 2; but this approach is compensated by an increasing distance from the earth so that the gain may be small. The ephemeris by Levin and Foxell is continued here for April, assuming $T = 1935$ May 1.8.

EPHEMERIS OF PERIODIC COMET REINMUTH

1935 0^{h} U.T.	α h m	δ ° ′	—Distance from— Earth	Sun
Mar. 27	5 42.3	+22 12	1.79	1.90
April 4	5 59.0	22 50		
12	6 17.8	23 20	1.91	1.88
20	35.5	23 38		
28	6 54.9	23 45	2.04	1.87
May 6	7 14.8	23 41		
14	35.1	+23 25	2.17	1.87

PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) has remained extremely faint, around 17^{M}, but the record is very incomplete. It was in opposition in Leo on March 11.

Search ephemerides have been published for COMETS 1930 VI (SCHWASSMAN-WACHMANN) and 1929 II (FORBES) which are expected at perihelion next November but the presence of these objects has not yet been revealed.

Williams Bay, Wisconsin, March 20, 1935.

Asteroid Notes

By HUGH S. RICE

The planet 433 Eros, our third nearest planetary neighbor in space, and which was so well observed at its recent near approach in 1931, will be under observation again this year. This is like the return of a periodic comet. The synodic period of this object being 2.3 years, the second apparition or appearance near the earth since January, 1931, takes place this summer. At this time it can be picked up with a 4-inch telescope, or with more difficulty with a 3-inch glass. At the present time it is in Capricornus, and at the time of opposition, August 19, it will be in Aquarius. A glance at the ephemeris and another glance at the Himmels-Atlas by Schurig-Götz place Eros, at the latter date, very near Messier 2, a magnificent round nebula, according to Webb, but called a globular star cluster by later authorities.

The exact positions of Eros for the rest of this year have been computed at the *Astronomisches Rechen-Institut* at Berlin-Dahlem. The ephemeris is contributed by R. Hiller, and is computed from the elements by G. Witt. Special perturbations are applied (by Kahrstedt), because of the proximity of the little planet to the earth, Venus, Jupiter, and Saturn. From the data it is evident that at the end of April the asteroid will be about 156,000,000 miles from the earth. At the time of closest approach for this apparition, about August 26, its distance will be about 67,000,000 miles, and so this year's opposition will not be a favorable one, as this distance does not compare well with the approximate distance from the earth of 16,000,000 miles in 1931. We observe in a column headed "lg r" that opposite "Dez. 32" we get "0.1450" which translated means that at the end of the year planet 433 will be about 130,000,000 miles from the sun; as the distance from the sun will have been decreasing steadily until this date, and as the perihelion distance of Eros is about 105,000,000 miles, it is evident that perihelion time will not be reached until early in 1936.

Ceres is still visible in Gemini; it is now back on its eastward path, and has been observed numerous times by the writer. It is still, at the present writing, near Castor, but its magnitude is gradually diminishing, as it draws farther away from the earth. It seems to have been somewhat fainter at this opposition time than its predicted magnitude. We do not have any ephemeris that shows its movement east of Castor, so we should be glad to hear from any enthusiasts who may follow it after it has gone off the chart which was published in the February issue of this journal, page 128.

Vesta will be coming into a better place and time for observation as the spring and summer progress. During April it is going through rich star fields of Capricornus and Aquarius. On April 12 it rises 3½ hours before the sun. As this is inconvenient for most observers, especially at this time of the year, the asteroid will not receive so much attention as later in the season or in summer, when it will be better placed. On April 20 its distance from us will be about 232,000,000 miles.

In the early morning of April 10, Vesta will be just northeast of the star

45 Capricorni, having been practically in coincidence with the star a few hours earlier. The brightness of the asteroid will be $7^{M}.7$ at this time. On April 15 it will be found 0°.5 south of μ Capricorni. On April 22 it will be 0°.6 north of ι Aquarii. On April 29 it will be 0°.2 north of 42 Aquarii. Its motion this month forms nearly a straight line, north of eastward, and it progresses about 0°.5 per day. On May 7 and 8 it will be 1° south of σ Aquarii. These positions should furnish a help in locating the object. Later in May it will be in conjunction with Saturn. This summer we expect to give a chart showing Vesta's apparent path among the stars.

There are no other bright asteroids to observe during the present period. As we have noted before, most of these planetoids are quite faint. In order to get exact data the writer made a count of all the 1301 minor planets whose elements and ephemerides have been given by the *R.-I.*, cited above, in order to find the number of asteroids appearing in each magnitude. The magnitudes are given in tenths, and the count is made so that when the tenths are 5 or more the asteroids are placed in the following class. As an example, 9th magnitude includes $8^{M}.5$ to $9^{M}.4$ as is customary.

Average magnitude at opposition	Number of planets occurring	Average magnitude at opposition	Number of planets occurring
7	2	14	360
8	2	15	102
9	11	16	13
10	42	17	9
11	141	18	2
12	213		
13	404	Total	1301

It is of interest to note the first 5 and the last 2 as follows:

Planet	Magnitude	Planet	Magnitude
4 Vesta	6.5	6 Hebe	8.5
1 Ceres	7.4	719 Albert	17.6
2 Pallas	8.0	1221 Amor	18.0
7 Iris	8.4		

By "first 5" we refer to the 5 asteroids having the highest average magnitude during their different opposition times. Albert is the one mentioned by Russell, Dugan and Stewart as having a diameter of probably but 2 or 3 miles. Amor is the interesting minor planet discovered by Delporte in 1932. It was then called the "Delporte Object"; it approaches nearer the earth than any other known planetary body except one known formerly as the "Reinmuth Object," Amor's least distance being about 10,000,000 miles. Its diameter is but 1 or 2 miles, according to H. Spencer Jones, in the new edition of his General Astronomy. Dr. Jones also notes two other interesting features, that Amor's orbit is similar to that of the asteroid Eros, and that the two bodies may have had a common origin [like separate fragments of one original comet traveling in their common orbit], and that Amor can be in the condition of exact opposition three times in the course of a few months' time. When the object is near the middle opposition point, the relative velocities of the earth in its orbit, and of Amor in its eccentric and inclined orbit are such that this condition is brought about.

Concerning Vesta in the above table, it is commonly said that this is the only asteroid ever visible to the unaided eye. The maximum brightness varies at different oppositions. In 1927 and 1931 we had maxima, with $6^{M}.0$, while in 1926 and 1932 its brightest was $7^{M}.0$ and in 1933 $7^{M}.2$. Therefore in some years it

can be seen with the naked eye, under ideal conditions. The brightest attained by Ceres is $7^{M}.0$ and it is extremely doubtful if this could be seen without optical aid, yet in 1802 Bode said in a letter to Herschel, ". . . Ceres was seen in March by several of my friends with the naked eye."

The following ephemerides are given of planets coming to opposition in April, from data of the *R.-I.* 13 Egeria goes westward in Virgo, passing about 1° south of the star 90 Virginis on April 18. 12 Victoria is also found in Virgo, in the southern part, in a region with no bright stars.

EPHEMERIDES OF ASTEROIDS FOR 0^{h} G.C.T. EQUINOX 1925.

13 Egeria $9^{M}.6$			12 Victoria $9^{M}.4$		
	h m	° ′		h m	° ′
April 4	14 5.6	−2 43	April 4	14 17.0	−21 4
12	13 57.4	−2 46	12	14 11.2	−20 17
20	13 48.7	−2 52	20	14 4.2	−19 16
28	13 40.2	−3 4	28	13 56.6	−18 3
May 6	13 32.2	−3 21	May 6	13 49.2	−16 44
14	13 25.4	−3 46	14	13 42.6	−15 23

American Museum of Natural History, New York, March 20, 1935.

Notes from Amateurs

Amateur Telescope Makers of Chicago

The Amateur Telescope Makers of Chicago held their monthly meeting on Sunday, March 3, at 2:00 P.M. in the Adler Planetarium and Astronomical Museum, Chicago.

Professor Clarence R. Smith, Professor of Physics at Aurora College, was the speaker. His subject was "Photographic Stunts for Amateur Astronomers."

Professor Smith described how the amateur can get some very interesting astronomical photographs with the ordinary camera and by means of a plate holder fastened to the eyepiece holder of the telescope which device can also be used for observing and charting sun-spots. He told us how to increase the usefulness of our telescopes with attachments which can be easily made at home.

The talk was illustrated by slides made by Professor Smith and should arouse the interest of the amateur telescope maker and influence him to use the instrument he has made.

WM. CALLUM, *Secretary.*

1319 W. 78th Street, Chicago, Illinois, March 14, 1935.

General Notes

Dr. R. G. Aitken, director of the Lick Observatory, will retire from active service on July 1. He has been a member of the observatory staff since 1895 and has devoted the greater part of his time to the measurement and discovery of double stars. His discoveries alone number about 3000. The Regents of the University of California have appointed Dr. W. H. Wright to succeed Dr. Aitken.

The Yerkes Observatory of the University of Chicago announces that during the summer quarter a course of 12 lectures on "Astronomical Photometry" will be given by Dr. H. Rosenberg, Director of the Kiel Observatory and visiting

professor at the Yerkes Observatory. These lectures will be intended primarily for graduate students and visiting astronomers.

The Toledo Astronomical Society held its monthly meeting in the Hall of the University of Toledo, Thursday evening, March 14. The program consisted of an illustrated lecture entitled "Reminiscences of Mount Wilson Observatory" delivered by Dr. Osgood of the Physics Department.

W. ALBERT HILTNER, *Secretary*.

2212 Grantwood Drive, Toledo, Ohio, March 18, 1935.

The Royal Astronomical Society is prepared to issue (provided sufficient support is forthcoming) a third edition of the Franklin-Adams Chart of the Sky, in 206 sheets, each covering an area 15° by 15°. The Chart is in three Sections,—(1) N. Pole to Decl. +22°, (2) Decl. +22° to −22°, (3) Decl. −22° to S. Pole. The price of the complete set, in three cases, has been fixed at £27, including carriage. Should any desire one or two of the Sections only, subscriptions will be received for the part required at a corresponding rate.

Further particulars, and application forms, may be obtained from the Assistant Secretary, Royal Astronomical Society, Burlington House, London, W. 1.

The Variable Star Bailey No. 95 in M3

S. I. Bailey observed two weakenings of the star Bailey No. 95 in the globular Cluster M3 on 1898 May 27 and 1898 June 15. It seemed to be an eclipsing binary. Many observations of Baade-Larink, Küstner, Pannekoek, Shapley were not sufficient to derive the elements. Prager and Guthnick made some 100 observations at Babelsberg with the 125-cm reflector in 1924-1925. One plate showed the star at minimum and it was clear that No. 95 had a long period. New plates of 1932 contained a completely observed minimum. On May 19 and May 20 the star was at normal light ($13^{M}.6$) and declined June 11 to $14^{M}.5$. There it remained until July 6. On July 20 it reached the normal light. The star seemed to be similar to ζ Aurigae. A small minimum took place also in 1923 and 1924 (Baade-Larink). All the minima can be represented by a period of 674 days but it is impossible to decide the question whether Bailey No. 95 is really an Algol star or an R Coronae Borealis object (See *Sits. Ber. Preuss. Akad. d. Wissensch.* 1933, XXIV).

G. R. MICZAIKA.

Berlin-Neutempelhof, 1934 October 19.

Book Reviews

Orbit Theory and Inaccurate Observations

In his review of my book, *The Calculation of the Orbits of Asteroids and Comets*, which appeared in POPULAR ASTRONOMY for January, 1935, Professor A. D. Maxwell makes the following criticisms:

"But here we find, . . ., and the continued use of long substitutions whose only values lies in simplifying logarithmic computation."

"The usual custom of determining angles from their tangents or cotangents, rather than from their sines or cosines, is in many places ignored."

"The notation is rather poorly chosen."

These criticisms are very sweping, and I do not think that there is adequate

basis for them. I have written to Professor Maxwell requesting citations that justify them, and saying that I intended to make a comment upon the review. He has very kindly replied to my letter. The objections he cites seem to me not only meager, but to be themselves quite debatable.

The only place where substitutions are employed to put equations in form for logarithmic computation is in the chapter on the Method of Olbers, where they occupy parts of about two pages. Furthermore, the substitutions are not long, but are short and simple, compared with many that occur in theoretical astronomy. The criticism occurred in a paragraph where the reviewer was discussing the book as a whole, and is thus unjustifiably misleading.

As to the second criticism, the reviewer states in his letter that he had reference to the formula for cos $(v_2 - v_1)$ which occurs on p. 103. He failed to observe that it is the cosine of half the angle that is later used, which will not be affected by the error in the angle on account of the slow change in the cosine when the angle is small. He also overlooked the footnotes on pages 155 and 158. It is quite true that an undesirable procedure for finding the argument of the latitude is given on pages 129 and 159. Formulas for both the sine and cosine are, however, given, so that the computer has the means of handling the situation. But the apparently unnoticed fault is hardly justification for the words "many places" that the reviewer uses.

In his letter the reviewer says, in support of the criticism of notation, that I use n instead of μ for mean motion. He also calls attention to the fact that my use of X, Y, Z is not uniform. The letter n is used for mean motion by many writers; it is so used for instance by Brown and Shook in their recent *Planetary Theory;* it is also so used in the introductory pages of the *Connaissance des Temps.* The reviewer believes my use of X, Y, Z will confuse the student. The careful reader will find no less than five footnotes in the book inserted for the purpose of preventing confusion from notation. If one uses a letter for only one purpose in orbit theory he soon immobilizes most of the alphabet. His only recourse is a complicated scheme of subscripts or superscripts. If my use of X, Y, Z will confuse the reader I do not think he is qualified to study the subject.

K. P. Williams.

Indiana University.

Newton's Principia—A Revision of Motte's Translation of 1729 with a Historical and Explanatory Appendix by Florian Cajori. (University of California Press, Berkeley, 1934. xxxv + 680 pages. $10.00.)

The appearance of this new edition of Newton's Principia in English by the late Florian Cajori, professor emeritus of the history of mathematics in the University of California, and, in the same year, a biography of Isaac Newton by Louis Trenchard More (published by Chas. Scribner's Sons) will stimulate anew the interest of English speaking scholars the world over in the work and life of that remarkable man, Sir Isaac Newton.

Old editions of the *Principia* in English are out of print and scarce, and it is too much to expect that the young student of today, who is equipped mathematically to understand it, should also be prepared to read it in the original Latin. A new English edition therefore is very welcome to the rather small group of scholars who desire to understand it. It is not easy reading for anyone. The tale is told that DeMoivre, a noted French mathematician, happened to be at the Duke of Devonshire's when Newton called to present a copy to the Duke. "The young mathematician opened the book and, misled by its apparent simplicity, thought he could master it without any difficulty. He soon found that it was beyond his

comprehension, and that he had a long, and thorny, road to travel before he could understand it. But he bought a copy, which he tore into sheets so that he could carry a small portion in his pocket and study it in the intervals of his other work. Yet men like John Locke and Richard Bentley, who were not mathematicians were fascinated by its philosophy. And the latter asked Newton to suggest a course of study which would prepare him to understand it. He received such a portentous list that he gave up the project lest the preparation would require the better part of his life. But he did by correspondence obtain enough insight into the author's philosophy to use it as an argument for the confutation of atheism in his famous Boyle sermons. The concluding lecture of the series was devoted to the purpose of proving the necessity of a Divine Providence, because of the orderliness in the laws of nature as demonstrated in the *Principia*." (Quotation from More's Biography.)

Cajori has followed Motte's translation exactly except for the substitution of modern phrases for a few obsolete ones, *e.g.* "inversely as the square root" instead of "reciprocally in the subduplicate ratio." This is certainly all to the good, but he might have gone much farther in modernizing the translation, as the Greek scholars have done in recent translations of the Bible. No one today would think of saying, as Motte does in Definition I. "The quantity of matter is the measure of the same, arising from its density and bulk conjointly"; and in many other places the English has a distinctly musty flavor.

Perhaps, if Professor Cajori had lived to see the completion of his work, there would have been more changes in this direction. Unfortunately, he died in 1930. His manuscript contained no Preface and he had prepared no index. His manuscript, however, did contain "An Historical and Explanatory Appendix" of 55 pages with much critical and otherwise interesting material. For example, in Note 21, regarding Lemma XXVIII of Book I,

"There is no oval figure whose area, cut off by right lines at pleasure, can be universally found by means of equations of any number of finite terms and dimensions."

Cajori refers to an example given by Brougham and Routh in 1855 to show that this lemma of Newton's is incorrect, but there are so many evident errors in Cajori's citation that the reviewer hesitates to say just what the example was. If the particular example given

$$y^2 = x^3(a^2 - x^2)$$

is correct, the area included between the y-axis and a parallel line at a distance x is

$$A = \tfrac{2}{3}[a^3 - (a^2 - x^2)^{3/2}]$$

which, though irrational, is not transcendental, and which, for $x = a$, gives the area of one loop of the entire curve

$$A = \tfrac{2}{3}a^3,$$

which is rational.

It would be somewhat comforting to us lesser mortals to know that, with respect to errors, even Newton was human, but the above example does not quite conform to Newton's specification that the right lines are to be drawn "at pleasure." The example cited gives the areas only for lines parallel to the y-axis, and is, therefore, not at all convincing.

Notwithstanding his success in placing mechanics upon a purely mathematical foundation by means of the three postulates, or axioms, as he calls them, of motion and the postulate of gravitation, Newton was not a complete mechanist, or

determinist. Evidently he believed it was necessary for God to interfere now and then, for he was a zealous upholder of the postulate that there exists a God. Indeed, in his day it was dangerous not to be. It was not until his successors had developed the subject of celestial mechanics to the degree of perfection which it had attained early in the nineteenth century that one could say with any degree of confidence "There is no need for such a postulate." In his biography of Newton More charges Laplace with arrogance for his remark, and others have done the same; but no arrogance is intended. It is just a plain statement of fact. Just where, may we ask, can one use this postulate in a mathematical argument? Scientific men, while they are engaged in scientific work, never appeal to it; they appeal always to the principle of uniformity. It is only when men become lost in the dense jungle of their own ignorance that this postulate has any value, and its value then is in the domain of the emotions. It is soothing, just as the sympathy of the mother is soothing to the child.

Newton did not use the postulate in the development of his theorems any more than Laplace used it in his *Mécanique Céleste*. Could he have seen the extraordinary development of his subject as Laplace saw it and we see it today, it is doubtful that he would have entered upon the discussion of God that is contained in the General Scholium of Book III, for Newton's first rule of reasoning in philosophy is

I. *We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearance,* "for Nature is pleased with simplicity, and affects not the pomp of superfluous causes."

As for his famous statement "I do not frame hypotheses" he meant merely that in the *Principia* he entered into no speculations as to the physical nature of gravity and the mechanism by which it acts. For his purpose such speculations were unnecessary and superfluous, so he would not enter into this debatable field. Elsewhere, in his letters and books, he was as ready to speculate as any other intellectually active man.

As to contents, the present volume contains:

1) Frontispiece—Portrait of Newton, from an india ink drawing made about 1691.
2) A facsimile of the title page of the first edition of the *Principia*.
3) The Ode dedicated to Newton by Edmund Halley.
4) Newton's Preface to the first edition (1686).
5) Newton's Preface to the second edition (1713).
6) Cote's Preface to the second edition (1713).
7) Newton's Preface to the third edition (1725-6).
8) Definitions and Axioms, or Laws of Motion.
9) Book I, The Motion of Bodies.
10) Book II, The Motion of Bodies (in resisting mediums).
11) Book III, The System of the World.
12) An Historical and Explanatory Appendix, by Florian Cajori.

The volume is thoroughly modern and attractive in appearance, and the press work is all that could be desired.

W. D. MacMillan.

Atlas Stellarum Variabilium, Series VIII, issued from the Vatican Observatory at Castel Gandolfo, under the editorship of the director, J. Stein, S.J.

This series contains 41 charts with 61 variables and the lists of comparison stars for each. A full description of this work is given in the Praefatio. For the

benefit of the English reader a translation* of this preface is given here.

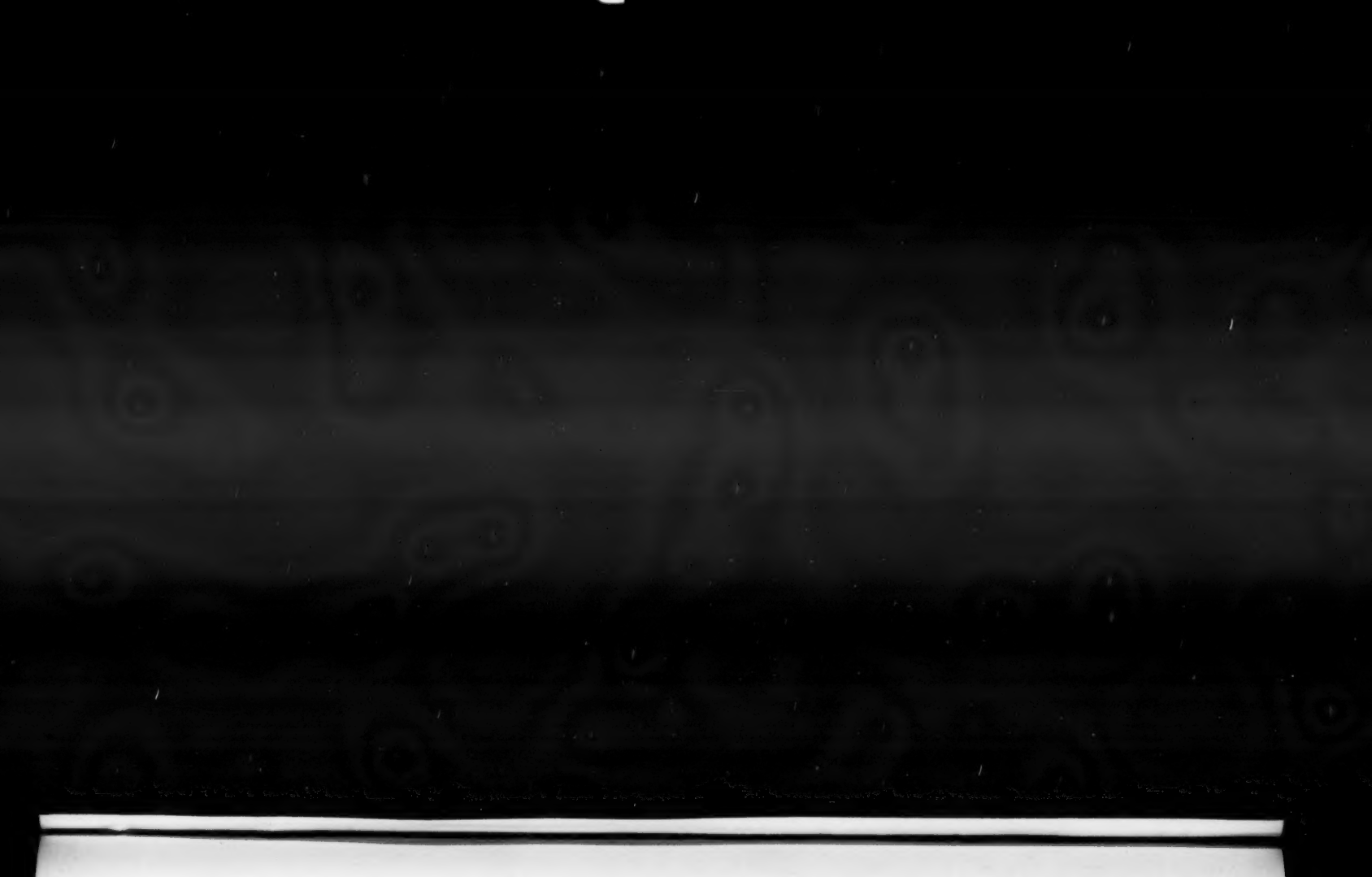
The variable stars that are contained in this Series were selected as early as the year 1823 by Father Hagen. In the following year the regions about the variable stars were photographed under the direction of C. Diadorus; in the year 1925 Dr. Fr. Becker, who was then assistant astronomer of the Vatican Observatory, selected the comparison stars and determined their gradations of light visually, using in this work a 16-inch telescope. The stars selected for the several charts to be observed photometrically had been taken over by Professor K. Graff who was then the astronomer in the observatory at Hamburg-Bergedorf, and he soon began this work. P. M. Esch, S. J., the director of the Observatory at Valkenburg, took up the work of measuring the positions of the stars from photographs, and also establishing a continuous series of magnitudes from the gradations of light compared with the photometric magnitudes; in this work to decide doubtful points it was necessary to make new observations and to make provision that all these results should be reported as correctly typographically as lithographically.

But as time passed delays were caused not only by the long illness and death of Father Hagen but also by the appointment of Professor Graff to the directorship of the Observatory at Vienna. As a result of this Professor Graff having been kept from his work was compelled against his will to give it over before the task that had been undertaken had been completed. Since on account of the proposed transfer of the Observatory to Castel Gandolfo and its new installation there, we could not find time to undertake this work, at the beginning of the year 1932 we called to our assistance Dr. H. Shapley, the Director of the Harvard Observatory. He, having carefully considered the matter with Dr. Cecilia Payne, gladly promised that he would soon undertake the task that was by no means a light one, but with this condition, that photovisual magnitudes should be substituted for visual ones. We very gladly and gratefully accepted this condition. For now generally for visual observations of variable stars a homogeneous system of magnitudes was desired. And on this account in a council of the International Astronomical Union held at Cambridge an international photovisual system was strongly recommended, and also the work of determining the series of photovisual magnitudes for variable stars was taken up by Miss Cecilia Payne with the hearty approval of all. Furthermore the same council authorized that before that work was carried farther and united in one system of magnitudes, astronomers should observe as many variables as possible of Series VIII A.S.V. as soon as the series was given out by the Vatican Observatory.

When scarcely a year had passed from the time when the charts, in which the selected stars had been marked by P. Esch, had been received, Miss Francisca Woodworth Wright, to whom that work had been assigned by Miss Payne, furnished in its entirety and in splendid fashion a catalogue of the photovisual magnitudes of 1920 stars. In *Harvard Bulletin* 892 she presented a discussion of the stars that were related to this task. In this you will see that the magnitudes agree very well with the photovisual system of Mount Wilson.

I feel that nothing is more in keeping with the rules of ancient courtesy than that we should express our heartiest thanks to the individuals who in a spirit so ready and kindly have given their work to help complete this series VIII Atlas Stellarum Variabilium.

J. Stein, S.J.

Castel Gandolfo, June 8, 1934. Director of the Vatican Observatory.

*Translation by Dr. Charles N. Smiley, professor of Latin Language and Literature in Carleton College.